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ABSTRACT

Included in this document are a selection of articles reprinted from SCIENCE AND CHILDREN. They focus on environmental education in the elementary school, and present a number of environmental perspectives. Those concerning general or background information are: an examination of environmental education: children's attitudes about the environment; teaching resources in the national parks; and a school/community effort to preserve an urban environmental study area. Ecology is treated through investigations at the individual level, populations of one species, communities, and ecosystems. Adapting traditional activities to an ecological approach, emphasizing concepts of interaction and change, is suggested. Earth science experiences to increase awareness of the child's own and natural enviornment center on site experiences. They focus on analyzing small parts of a larger environemnt--investigating change, age, movement, erosion, deposition, etc. The field trip is presented utilizing a conceptual approach to develop environmental relationships. Suggested activities for children for observing their town as a man-dominated biotic community are examining construction, tree identification, soil samples, zoo trips, food chains, and succession. A calendar for teaching conservation activities is constructed. One article is devoted to the associations between nature and creativity. References are included following some articles. (BP)

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EDUCATION

ENVIRONMENTAL EDUCATION IN THE ELEMENTARY SCHOOL

A Selection of Articles
Reprinted from

SCIENCE and Children

NATIONAL SCIENCE TEACHERS ASSOCIATION 1972

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ENVIRONMENTAL EDUCATION IN THE ELEMENTARY SCHOOL

A Selection of Articles Reprinted from

SCIENCE and Children

Compiled by:
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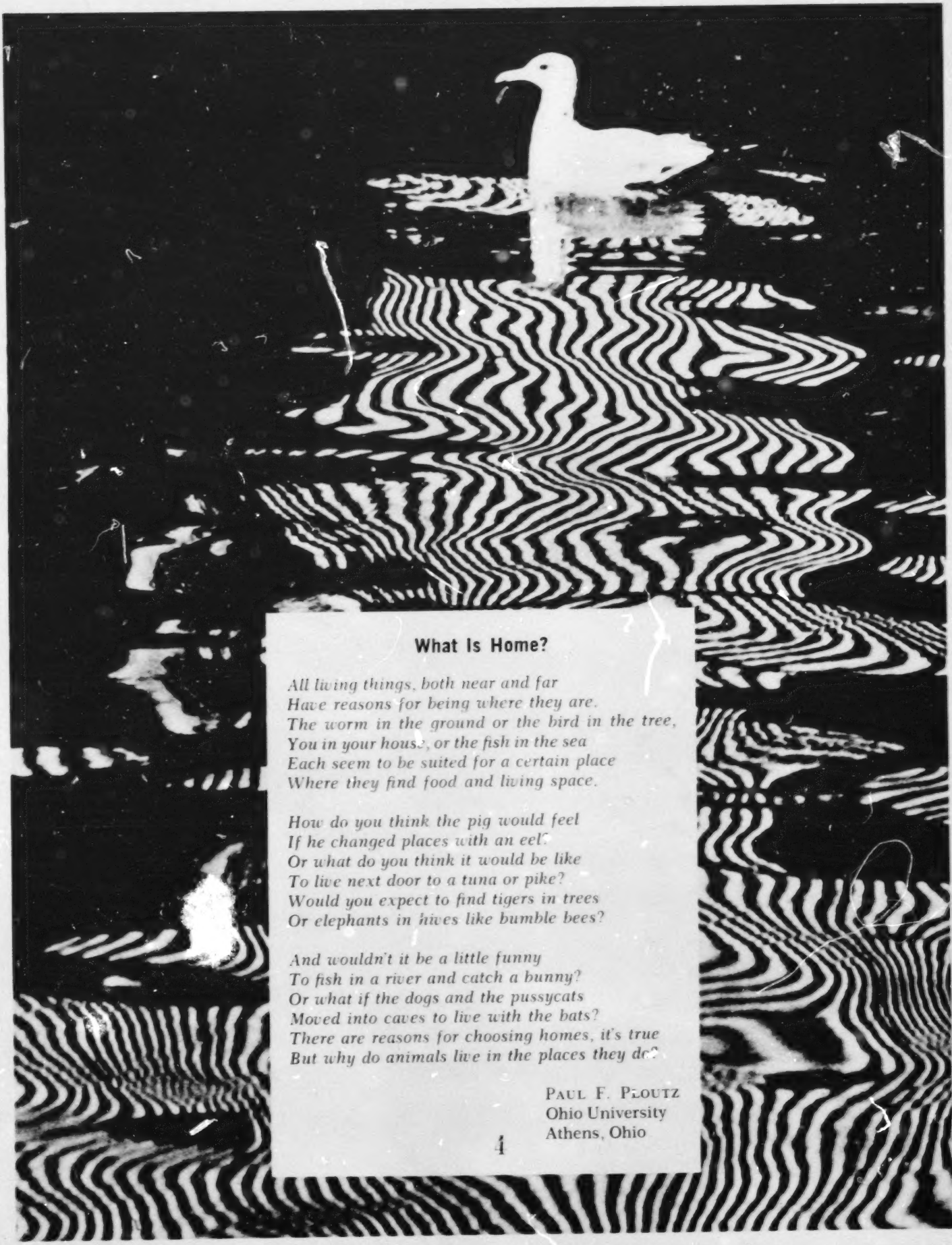

What Is Home?

All living things, both near and far
Have reasons for being where they are.
The worm in the ground or the bird in the tree,
You in your house, or the fish in the sea
Each seem to be suited for a certain place
Where they find food and living space.

How do you think the pig would feel
If he changed places with an eel?
Or what do you think it would be like
To live next door to a tuna or pike?
Would you expect to find tigers in trees
Or elephants in hives like bumble bees?

And wouldn't it be a little funny
To fish in a river and catch a bunny?
Or what if the dogs and the pussycats
Moved into caves to live with the bats?
There are reasons for choosing homes, it's true
But why do animals live in the places they do?

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A Closer Look at Environmental Education

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WITH the increasing degradation of our planet, words like *environment* and *ecology* have attained an emotionally-charged usage by the news media and by the general public. Not many years ago, few people knew what ecology was; today, nearly everyone is talking about the idea—or at least the word. Thus far, few of the words have been matched with deeds.

What's in a Name?

As man's environment deteriorated rapidly in the past two decades, the concerns of naturalists, conservationists, and even ecologists have gradually broadened in their perspectives. For example, the National Audubon Society, long known for its interest in outdoor education, recently re-stated its objectives to reflect a concern which has expanded from bird watching to man's total environment. The current objectives are:

> *To promote the conservation of wildlife and the natural environment.*
>
> *To educate man regarding his relationship with, and his place within, the natural environment as an ecological system.(1)*[1]

Conservation means different things to different people. Ever since the word was used about sixty years ago by Theodore Roosevelt, people have debated at length over whether it means *preservation* of natural resources or their *wise use*. A conservationist might be a person who works towards the complete preservation of a wildlife sanctuary or he might be a person who lumbers a forest while employing sound reforestation practices. Traditionally conservation has been rural in its orientation, with interests in such natural resources as water, wildlife, forests, and productive land. More recently, conservationists have broadened their perspectives to include environmental problems resulting from man's overpopulation of the planet and related problems of man's urbanization. Today it is not uncommon to hear reference made to the conservation of man as a species. Paul Brandwein, when serving as a director of the Pinchot Institute for Studies in Conservation gave conservation the following definition:

> *Conservation consists in the recognition by man of his interdependence with his environment and with life everywhere, and the development of a culture which maintains that relationship through policies and practices necessary to secure the future of a sanative environment.(2)*

Schools need to examine closely their existing outdoor education and conservation education programs in the light of the above changes. The orientation of the majority of outdoor education and conservation education programs fails to meet the urgent need of today's society—the education of man concerning his total environment.

Impatient with the existing time lag, James Swan of The University of Michigan advocates the development of more suitable programs under the banner of *environmental education*. He argues that although outdoor education has some goals which are closely related to environmental education, it is basically nature-study oriented. A number of such programs include a week-long trip to a wilderness camp while neglecting the study of living organisms within the immediate environment of the school. At the camp it is possible to interest an inner-city child in the beauty of the wilderness, but there is little

[1] See References.

likelihood that this experience will transfer to contribute to a child's awareness of his urban environment.(3)

Much conservation education also fails to focus on the environment of the urban community, even as the majority of the nation's children lives in urban settings. The teaching of forest-fire prevention, even with the aid of Smokey the Bear cartoons, has little relevance for an inner-city child who has never been camping in a forest. Conservation education has often deteriorated to the presentation of a set of rules, devoid of related experiences and oversimplified to a degree which has obscured their scientific base. For example, little attempt has been made to correct the half-truths taught in the primary grades in the interest of fire prevention. Conservation education programs should include, at some point, a study of fires as a natural part of the growth cycle of certain trees[2] and the use of controlled ground fires (environmental burns) as a tool of foresters. Stripping the forest floor of brush alleviates conditions of overcrowding, which prevents the growth of seedlings. It also prevents the accumulation of dead fuel, which can sustain more devastating fires.

In defining environmental education, James Swan writes:

> *Environmental education may be conceived as being directed toward developing a citizenry that is knowledgeable about its environment and its associated problems, aware of the opportunities for citizen participation in environmental problem-solving, and motivated to take part in such problem-solving.(3)*

The need for programs that educate man regarding his relationship to the total environment is undeniable. This need is also reflected in the developing conceptions of outdoor education and conservation education. As modern conceptions of these educational programs increase in similarity the choice of labels for them decreases in importance. However, the problem of translating these conceptions into viable school programs still remains.

A Cautionary Note on The Quality of Enviromental Education Materials

The editors of *Environment*, a journal published by the Scientists' Institute for Public Information, have expressed a concern for the sudden appearance of a publishing industry "to feed, and sometimes to feed upon, the national movement to save the natural environment from destruction." They conceive of this deluge of publications as "growing to such proportions as to constitute a threat to the environment itself."(4) A number of such paperback publications have found usage in upper-elementary classrooms with little regard for quality or reading level.

Similarly, a number of school programs have been developed hurriedly in response to both the need and to the growing market. In some cases, unrelated outdoor and conservation education activities are merely sprinkled liberally with the "in" terminology. The relationship of these activities to man's total environment receives only superficial treatment. Needless to say, all materials require careful scrutiny prior to adoption for use in the classroom.

Some Recent Programs of Note

People and Their Environment (5) is an eight-volume set of Teachers Curriculum Guides to Conservation Education which contains two volumes of concise lesson plans developed for use in the elementary school. These volumes represent an extensive catalogue of conservation ideas and resources which are related, though loosely, to such themes as "living things are interdependent with one another and with their environment," and "a living thing is a product of its heredity and environment." The program does not require expensive materials and its loose structure permits the teaching of individual lessons in a variety of situations.

Although few available programs place sufficient emphasis on man's relationship to his total environment, some of their units or lessons could effectively supplement other programs. The Elementary Science Study (ESS) (6) has created a number of independent units which relate to the biological world. These units provide children with firsthand experiences with raising plants, molds, earthworms, and brine shrimp; collecting pond water specimens, and observing their life cycles. However, each of these in-depth experiences remains to be related to a broader scheme. Several ESS units could effectively supplement other programs such as the one mentioned above.

Recent contributions have recognized the importance of urban children becoming aware of events in their immediate environment. The National Audubon Society has published a study unit for fourth and fifth graders entitled *A Place to Live* (7). An awareness of the urban environment and its related problems is developed through reading and discussion of firsthand experiences gained from ten walks into the surrounding community. Each of the walks focuses on a separate aspect of the environment, e.g., location of buildings, the variety of materials used in building construction, animal traces, trees, birds, ants, plants, soil, environmental problems, but no walk requires transportation to a nature site. The supplementing of these experiences with some in-depth classroom investigations would make this a more effective unit.

The Environmental Studies (ES) project has been pilot testing units which were written specifically for teachers for use over a wide grade range in urban settings. Successful

[2] Fires are a great menace to all trees which grow in the forest and change the forest for decades to come. However, some of the trees could not exist without fire. The destruction of seedlings, the weakening of the dominant trees, and the removal of litter from the forest floor produce conditions which are favorable for the growth of certain trees. For example, the heat of the fire stimulates the dormant cones of the lodgepole pine to open and to release thousands of seeds which are able to germinate and thrive on the ash-covered soil. Unless fire recurs the growing conditions in the forest change. Over a period of years the pines grow taller and closer together, providing suitable conditions for the shade-enduring firs whose light-weight seeds blow in from outside the area. Eventually, the lodgepole pine will be replaced by the more dominant species.

Since lightning is the cause of 95 percent of all forest fires these cycles have been recurring prior to the intrusion of man. The use of controlled fires by the U.S. Forest Service is an attempt to restore fire to its ancient and natural role in the forest ecosystem.

trials have been reported in classes as low as grade three. Four themes recur through a series of loosely organized activities. Brief descriptions of these themes are:

> *Change* is a phenomenological approach that is involved with cause and effect. When using these materials students are invited to search out what's happening in the environment and why.
>
> *Mapping* is a spatial approach and is primarily concerned with where things are in one's immediate environment.
>
> *Counting* is a statistical approach and is focused on determining how the environment can be better understood by counting certain qualities in it.
>
> *Judging* is the evaluative set of materials. It is designed to engage the students in the process of making value judgments about the quality of environments that they experience.(8)

Each activity is presented in an open-ended manner which encourages a high level of involvement and creativity. As a result of such interaction with their immediate environment, the children are expected to demonstrate more confidence in themselves as agents of inquiry.

A Cautionary Note on Child Development

In our dedication to the environmental cause there is a danger that we become overzealous and be deceived by children's verbal performance in the classroom. The following example, reported in a conservation club bulletin, depicts a first grader's study of ecology, ecosystems and pollution.

> . . . The six year olds delve into smog and DDT, organisms and habitats, water problems, and conservation of African animal life. No subject concerned with planet earth is taboo . . . The science room is covered with articles of interest: a news story and pictures of a Minnesota fish kill; an article on a new and complex system of converting salt water to fresh . . . One lad spelled out his theory for eliminating smog, a simplistic idea, perhaps, but to the point. "Make difrent ingin for cars, trucks, and motor cycles *(sic)*." Others in a free-wheeling discussion on air pollution called for development of an electric auto, a steam driven car, and a return to the use of feet . . . In a discussion of pesticides, a girl gave a lucid explanation of the role of DDT in the demise of the pelican. Using the Redwood poster as a takeoff, another girl left no doubt that she understood the cause and meaning of erosion.(9)

Although much time in this first-grade classroom had been devoted previously to firsthand activities with plants and animals, these experiences did not develop understandings which could support an intelligent discussion of pollution or ecosystems. Children should not be deprived of expressing their interests, but we, as teachers, should not misinterpret such discussions as reflections of their true understanding.

In the class described above, one boy mentioned the replacement of the existing internal-combustion engines. However, it is highly unlikely that he had the intellectual development to understand the principles of combustion, let alone an understanding of combustion under high pressure. More likely, the child, having acquired an enthusiasm and a vocabulary from television and from adult conversation, was merely imitating a chain of words.

Piaget had demonstrated that children are incapable of thinking like adults. During most of the elementary school years children's thinking requires referral to concrete experiences. Piaget classifies this stage of cognitive development as concrete operational.[3] Firsthand experiences with plants and animals may contribute to the foundation for an understanding of the ecosystem concept. First graders, however, are unable to focus on the multi-dimensional interaction represented by this concept. This understanding must precede an intelligent discussion of pollution problems which affect its balance. The Science Curriculum Improvement Study (SCIS) (10) which has developed a life science sequence in accordance with Piaget's theory of children's cognitive development, has deliberately postponed the study of these topics until the sixth grade. At this level, according to Piaget, many children are in the transition to a stage of abstract thinking in which they gain the potential to study multiple dimensions of more complex problems.

The SCIS Life Science Program concentrates on a relation of observable organisms to each other. Children undertake increasingly complex investigations involving the organisms, and the concepts they learn are increasingly expanded. In parallel with the cognitive development of children, their attitudes about living things and themselves are developed, and specific requirements for specific organisms are considered.

In the sixth grade, the development of the ecosystem concept integrates previous experiences and extends understanding of related concepts. Children summarize their experiences with a combined aquarium-terrarium system to include the interrelationships of its parts as shown in the diagram. Following the development of a sound scientific base of concepts from ecology,[4] the science of ecosystems, pollution problems are only then investigated. Through the investigation of effects of excess carbon dioxide on the behavior of fish and the effect of excess thermal energy on daphnia and algae populations, the children realize that any harmful deviation from the natural environmental conditions of the ecosystem can be classified as pollution. The disturbance of the delicate interrelationships illustrated in the diagram are demonstrated when aquarium-terrarium systems are subjected to smoke pollutants from a smoldering string.

To encourage discussion of an endangered animal species outside the study of its relationship to its total environment (as was being done in the classroom mentioned) is to encourage mindless sentimentalism. The SCIS program provides first-hand experiences through which children develop attitudes of care and responsibility for living things which are based on the environ-

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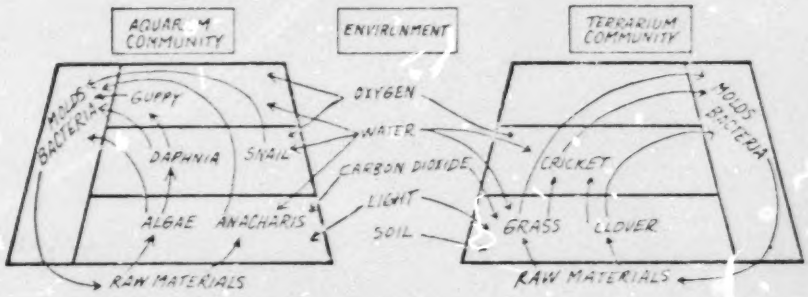
[3] For more information on Piaget's work and its implications for science teaching, see the article "Piaget and Elementary Science," by Edward A. Chittenden, *Science and Children*, December 1970, pp. 9-15.

[4] To distinguish ecology from conservation, it may be said that conservation is ecology applied, or a philosophy of action based on ecological principles.

[5] From *Ecosystems*, Trial Edition, by the staff of the Science Curriculum Improvement Study, Berkeley, California. February 1970, p. 29.

ECOSYSTEM[5]



mental requirements of organisms for which they are caring. The children also develop an understanding of the interdependence of organisms and their food chains. (11)

Furthermore, given enough time to experiment with their bio-physical environment, children can gradually develop a belief in their own ability to change things and to control the outcomes of an event. Mary Budd Rowe of Columbia University has observed that young inner-city children interpret events in their life as a matter of fate; they are either lucky or unlucky. She places great faith in science education as a means of combating the inability of these children to act on their own behalf.

> *Science and prediction go together. The more I know about a system, the more I am likely to act on it in different ways and expect certain results. Prediction rests on a belief that events are not totally capricious; that what I do to the system makes a difference in how the parts act. I can, in some way, act to control the fate of the system. Probably the building of this belief represents the single greatest contribution science can make to the education of the disadvantaged child.(12)*

The SCIS program also contributes to the development of a positive self-concept which is essential to environmental problem-solving—a goal of environmental education.

New Directions

Unfortunately, pollution problems cannot be studied in isolation. They must be investigated within the scope of the socioeconomic and political as well as the biological and physical environments. The self-concept which is essential to environmental problem solving must be sustained through an understanding of the measures available to the citizen within the socioeconomic and political systems for the initiation of change and hence the control of their fate. In the sixth grade, the children who have reached the stage of abstract thought can benefit from the opportunity to become involved in simulations of environmental problems. Such simulation games provide immediate feedback on the consequences of their decisions. The experiencing of conflict between environmental needs, personal values, and vested interests during decision-making can dispel the naive view that "only bad guys pollute." A small number of such simulation games has been developed for the study of environmental problems in the upper elementary grades. Although the majority are unpublished, two such simulations have been reported by Asmussen and Cole (13) and Kracht and Martorella (14).[6] Once again, in deciding whether or not to use such a simulation game the classroom teacher must be sensitive to the intellectual development of her children.

Science educators can no longer isolate themselves from scholars in other disciplines when developing environmental education programs. Only a cooperative effort can provide a suitable interdisciplinary background for the study of environmental problems.

[6] One game of such design, "Disaster," is described by its developer, Bonnie Barr, in the November 1970 issue of *Science and Children*, pages 24-25.

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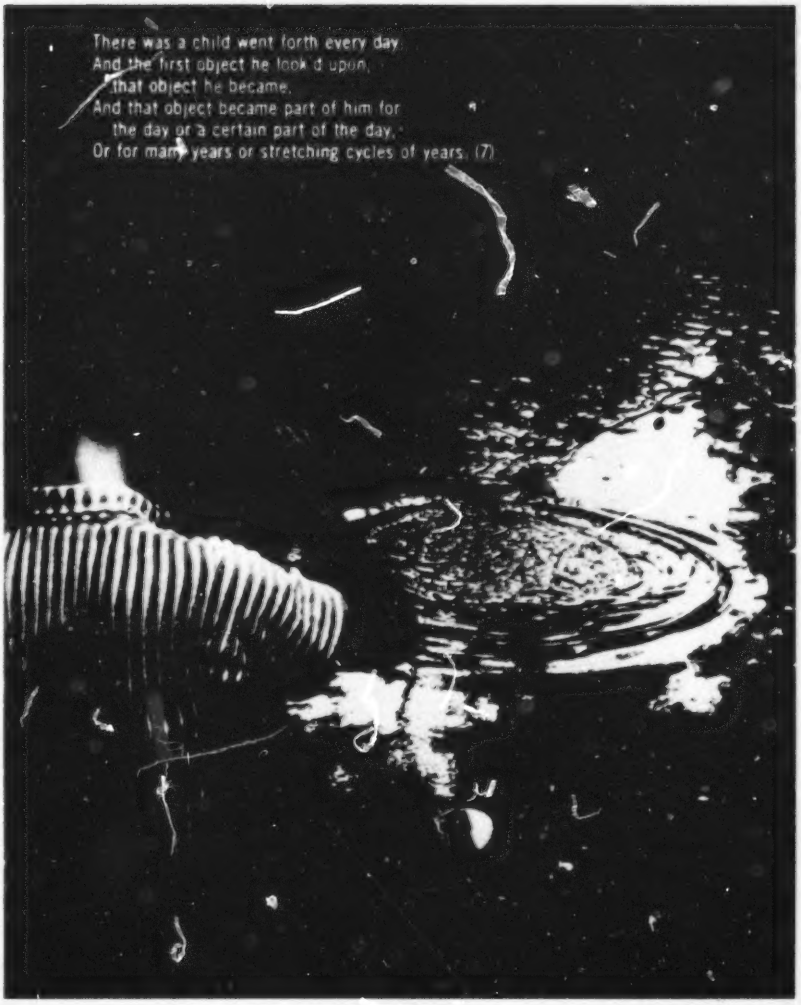
There was a child went forth every day,
And the first object he look'd upon,
that object he became,
And that object became part of him for
the day or a certain part of the day,
Or for many years or stretching cycles of years. (7)

Young Children's Attitudes About Environment

SINCE the poetry to the right was written long before people thought about how children came to know the world around them, educators have come to know that children learn much by doing. Today, through doing, teachers seek to help children, and themselves, to explore and interpret their environment. Teachers can lead children who are young in years or young in experiences toward the development of wholesome attitudes—attitudes about their world and about themselves.

Attitudes begin developing in children along with awareness. Using visual, auditory, and tactile perceptions, the child comes to recognize and to know objects, people, and events. He sees the patterns, shapes, and designs of leaves. He feels the tree bark or the lumpy toad. He hears the automobile engine or the school bell or the robin's song, and he comes to know these sounds and to relate them to the source of the sound. Teachers lead him to discover likenesses, patterns, sequences, and relationships through explorations, indoors and out; through interaction with people, talking, listening, sharing; through drawing, writing, and reading; through books of all kinds, poetry and pictures, real and fanciful.

Gradually, the child understands that things have more than one property or characteristic. He finds out that it is more than feathers that characterize a bird. He gradually grows to understand that the bird is, at the same time, a bird, a woodpecker, a downy woodpecker, a climbing bird, and an egg layer (1).* But this idea of something being in a class that is, in turn, a part of a larger class calls for a double reference. It calls for an understanding that things, objects, places, and people, can be a part of a class and a subclass simultaneously, and this process for the young child, the child with few experiences, can be confusing. Thus, we need to listen carefully to the questions children

* See references.

ask. They learn not through mere exposure nor mere imitation, but through interaction, manipulation, questions, and integration of experiences.

We know that many of the questions of young children represent their response to their social environment. Many of their questions are attempts to interpret their environment, but sometimes in a much more limited way than the adult supposes. When a child asks, "What's a caterpillar?" a teacher or parent may answer with some long explanation about insects. But the child says, "That's funny, Johnny says there's one digging a large hole in the street." We need to find out what the child knows, or thinks he knows, in order to know what information he really seeks. We need to provide time for questions, and time to listen and to know children.

During the beginning school years, four-, five-, and six-year-old children are learning to sort out what is real and what is fantasy; what is acceptable or not acceptable behavior. They are integrating within themselves the words, concepts, and values with which they are living. This orientation represents the child's incipient attitudes—not complete but well under way (4). Teachers do much to influence the way these attitudes are developing. As Dorothy Law Nolte writes, "Children Learn What They Live" (2):

If a child lives with criticism,
He learns to condemn.

If a child lives with ridicule,
He learns to be shy.

If a child lives with jealousy,
He learns to feel guilty.

If a child lives with tolerance,
He learns to be patient.

If a child lives with encouragement,
He learns confidence.

If a child lives with praise,
He learns to appreciate.

If a child lives with fairness,
He learns justice.

If a child lives with security,
He learns to have faith.

If a child lives with approval,
He learns to like himself.

If a child lives with acceptance and friendship,
He learns to find love in the world.

Because children live with teachers, teachers' attitudes toward children are of prime importance.

Among attitudes about the environment, teachers can help develop an understanding in children that living things are interesting in and of themselves. We do not need to give a cottontail rabbit human characteristics to find it interesting. A young plant or seedling is indeed a baby, but it does not need a mother. But let us not throw out Beatrix Potter's *Peter Rabbit*. The talking animals of *Peter Rabbit, Charlotte's Web, The Wind in the Willows* or Else Minarik's *Little Bear* do not really tell us about animals—but they tell us so much about ourselves, and we too are living things. Whenever possible, let us develop attitudes about living things through interaction with those living things. What is real and what is fantasy will be sorted out as children grow through their experiences. They need time and space for living things in the classroom; time to explore and discover living things outside the classroom.

We want children to be kind to living things, but with kindness built on understanding of the needs of plants and animals, not on maudlin sentimentalism. We do not need a watered-down version of *Black Beauty* to teach children how to care for an animal. *Black Beauty* represents a form of social criticism that is a far cry from the world of today's youngsters. However, a book such as *We Like Bugs* can give us information on which to develop understanding and attitudes.

We may feel tempted to pity the "poor, helpless worm" as some enterprising robin gobbles it up. But let us stress instead the hungry robin, as a step toward understanding food chains and the interdependence of living things. Thus, concepts develop as well as attitudes.

As children experience more of their world, they will in some form or another encounter death. Perhaps this encounter may be through watching the flowers come to bud, to bloom, and then fade. Perhaps death may be seen in the mangled remains of a squirrel in the street. Through these common and everyday experiences, the child can come to understand that death is a part of the life cycle of all living things. He learns that even though death changes the form of the previously living thing, he can still remember that living thing and enjoy the memories of it. He can come to know that in the new seeds of the old plant, or the noisy young squirrels, and in his own existence lie the ever-changing, never-ending continuum of all living things.

We have a tremendous opportunity to develop attitudes of respect and responsibility in young children. Often young children do not have clearly defined ideas of property or ownership. We can help them understand that the school yard is ours; the school room is ours; this notebook is mine and that one is yours. When outdoors, the sidewalks are ours, but that green lawn and those flowers belong to a neighbor. The flowers in the city park are ours, but we leave them

there just as we leave the wild flowers where they are so that others might enjoy them.

Children do respond to a challenge of responsibility when they feel they have a stake in the project at hand. Smokey the Bear has more than proved himself valuable in educating the public, children especially, about prevention of forest fires.

> Before the Smokey the Bear project began, 210,000 forest fires burned 30 million acres every year in the United States. Though five times as many people visit recreation sites today, the annual average has decreased to 100,000 fires and four million acres. (5)

Anti-litter campaigns would do well to emulate Smokey the Bear's appeal to children. Shall we start with the school grounds? Are they free from litter and trash? Let us not make the school grounds a fancy showplace with "Do not walk on the grass" signs. There should be reasonable responsibilities and reasonable boundary lines, so that a tree may be climbed—providing it is strong enough; that a hole may be dug in certain areas and filled again; that a garden may be planted if there are children to care for it. Teachers may use this convenient extension of the classrooms, the school grounds, frequently and appropriately in order to better understand the processes in our environment and develop concepts about these processes.

An appreciation of beauty is one of the lifelong values of the outdoors. To learn to see beauty becomes natural for children who have been encouraged in their discoveries, experimentations, and explorations. So often children see things in unexpected ways and places and so enrich the perceptions and appreciations of adults. We can learn from our children when we look and listen to what they see and say as they explore their world. The eyes of children will see beauty that often escapes us, if we can but give them time to look and time to share. Sara Teasdale says,

> Look for a lovely thing and you will find it.
> It is not far—It never will be far. (6)

In this setting near our doorsteps, we have a time and a place with an opportunity for meaningful, purposeful planning, doing, and responsibility. We have an ideal laboratory for learning that will not require a federal grant to maintain. And above all, there is an opportunity for learning through firsthand experience, observation, and participation—not just about the outdoors, but about each other. It is in knowing one another that our adult attitudes must be carefully examined lest we lead ourselves and our children to believe that superficial concerns can prevent learning; that clothing that is not of fine quality or well-cared for somehow diminishes a child's personal worth; lest we blind ourselves to the miracle of creation that each child represents.

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Environmental Education

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WHILE many teachers are fully aware of the need for a program of environmental education, they are often confused as to where to begin. What is needed is a carefully thought out plan of action at all levels of education promoting environmental sensitivity and responsibility. An adequate program of environmental education must not only encompass all levels of education but must reach students across the whole spectrum of human experience. In order to accomplish this, we must keep in mind that this is a total problem, the solution of which must take into account all the dimensions of human experience. There are decisions concerning environment to be made along the scientific dimension, the ethical dimension, the aesthetic dimension, and the utilitarian dimension. The following suggestions and proposals are presented as a starting point for thought and action on the part of teacher and student to the need for new approaches in environmental education.

The Outdoor Laboratory

The outdoor laboratory can range in size from a small, protected plot of ground where teachers can transplant their potted plants and where children can plant vegetables and other plants at appropriate times, to a considerably larger, scaled-down version of a miniature farm.*

Among the areas that elementary students might study are (1) soil and plant relationships, (2) plant growth and reproduction, (3) pest control and its possible side effects, and (4) the effect of fertilizer and its possible side effects from an ecological standpoint. The miniature farm would represent as closely as possible an actual farm; it could be used to teach erosion control as well as various conservation practices. Some school systems have woodlands available for organized study. If a wooded area is available for field trips, it can provide an ideal setting for students to observe, associate, and relate—to soil study, to the study of wildlife and forestry, and to more detailed nature study.

The Balance of Nature

The fact that all the plant and animal species inhabiting the earth are interrelated, and that destroying one can adversely affect many others is an aspect that should be emphasized in environmental education. Through the use of pesticides, the extension of agriculture to more and more lands, through unscrupulous exploitation and in a variety of other ways, man is modifying, threatening, and destroying species at a rapid rate. The upsetting of the delicate balance of nature in this way assumes tremendous significance not only from the scientific viewpoint but also from an ethical standpoint.

Along the ethical dimension, the peril to many of the endangered species can be illustrated in various ways. A unit on the great cats, including the threat of their imminent extinction because of the use of their skins in fur garments is a case in point. Children can quickly discover the relationship between survival and extinction on the one hand and economic exploitation of threatened species on the other. Some animals, however, are raised on ranches for their pelts, such as minks, and are not threatened by extinction. It would be useful to mention this contrast.

The case of the whale is an illustration of the plight of endangered species. The irresponsible slaughter of these creatures represents a serious threat to their existence. A learning design in this area could range from a simple unit on the whale for first graders to a relatively complex unit for sixth graders involving all the relevant scientific, ethical, aesthetic, and practical aspects. The plight of the whale presents an excellent opportunity to capture the child's imagination and turn it to useful ends concerning the survival of one of the world's most interesting mammals. Past experience with endangered species in-

* See also "An Urban ESA" and "Our Block of Earth" by Sylvia K. Shugrue and Janice H. Davis, respectively, in the January/February 1971 issue of *Science and Children*, pp. 21-23.

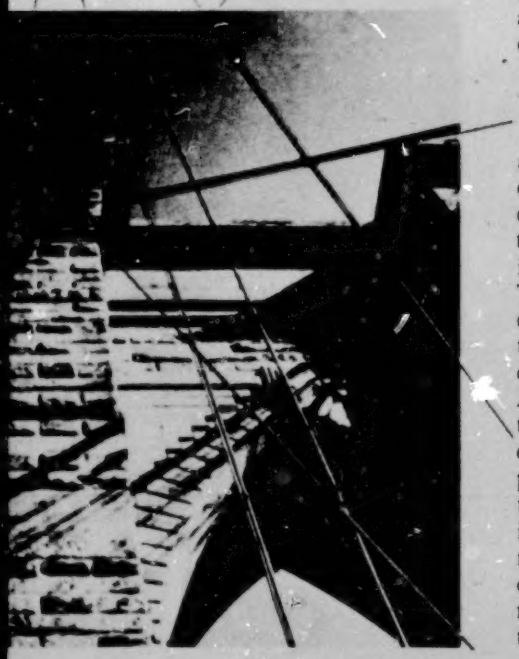
cluding the American bison and most recently the American alligator tends to show that public concern can result in apparently successful conservation practices, and this documentation of attitude reversal could be mentioned. You might ask your students what they would be able to do to help save the whales from extinction.

It has become readily apparent that an appreciation of beauty must be engendered in children if we are to preserve our quality of life at any meaningful level. Teachers of art, language arts, music, and other areas besides science should be brought together to participate along the environmental-aesthetic dimension as much as possible. Creative art shows with an environmental theme should be encouraged. In addition to creative art exhibits, children should be allowed and encouraged to write poetry and participate in drama expressing their feeling and emotions concerning the environment. Music should not be neglected as a source of environmental sensitivity. Environmental folk songs written at the elementary level are becoming available. Music teachers, or the teacher in a self-contained classroom who teaches music should help students to think about nature and beauty as well as to sing about it.

and backbones are engaged in a meaningful task.

Finally, it should be noted that these suggestions encompass an interdisciplinary, full-dimensional approach to environmental education and are meant to serve merely as a starting point for thought and action in that direction. It is felt that this is necessary since it appears that man's only chance of survival lies in his ability to adapt his thinking to changing circumstances. In this spirit, a sound program of environmental education can hopefully provide for an increased understanding of the options that man must explore if he is to survive as a species.

and the Elementary School



The above examples tend to fall readily into the affective domain. Since there is a great deal of human emotion involved in the struggle for man's survival this is appropriate. Perhaps we run a great risk if we emphasize the environment in the cognitive domain alone, so hopefully through the interengagement of thought, action, and feeling children will learn to behave responsibly and knowledgeably in the area of environment.

An Ecology Club

Science educators have frequently advocated science clubs at the upper elementary level. Why not organize ecology clubs to take advantage of the natural interest, curiosity, and idealism of this particular age group? The interdisciplinary nature of the ecology movement should allow any teacher who is vitally interested and concerned to sponsor such a group. An ecology club might go beyond the usual "club program" and become actively involved in certain projects aimed at actually getting things accomplished. While the various projects might seem to be of a minor nature to the more sophisticated, there should be no underestimating the energy and capacity of this age group when their feelings

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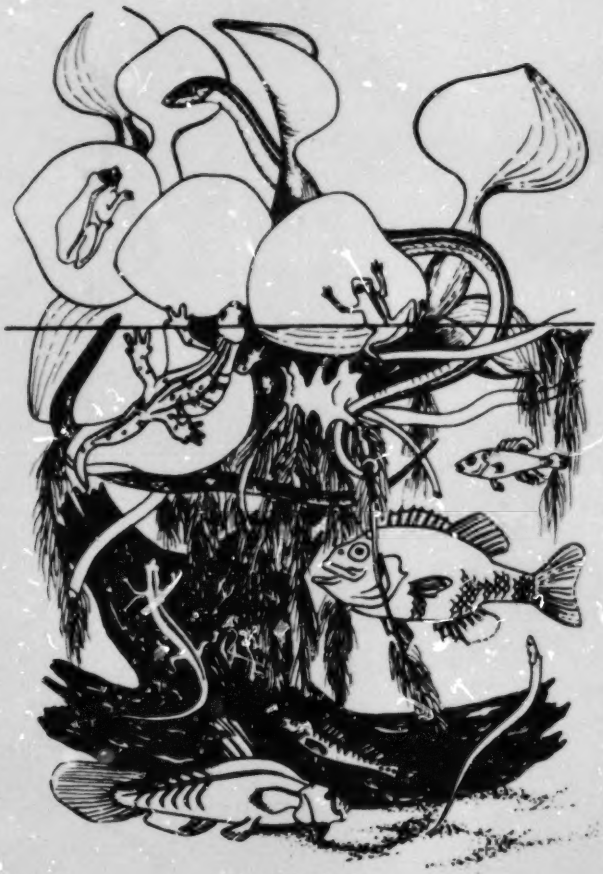

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Ecology

PART I: The Definition

ECOLOGY is the study of the way the world "gets it together." Everyone who reads is aware that the earth is a dynamic system in which energy flows and materials cycle. But this does not describe the complex machinery. What are the agents of the action? Where are the materials at any one instant? Where will they go next? How is energy used and lost as the materials cycle? Is this a reliable and stable system? At what points is it most vulnerable? What kinds of interference will threaten its stability?

The ecologist's business is to find answers to these and many other questions. Having accepted that the earth is a dynamic system, he searches for clues to its organization. What is its composition and how are the parts related? An interesting way of approaching the problem is to focus on the agents of transfer—the living plants and animals. Ecologists recognize four levels of organization among living organisms: the individual, populations of one species, communities of populations, and ecosystems composed of communities and their environment.

This article is taken from the series of Sunoco science seminars presented at the Nineteenth Annual Convention of the National Science Teachers Association in Washington, D. C. March 26-30, 1971.

The Individual Level

Individual plants and animals live where they do because they can survive there. The place that provides the optimum requirements of space, food, water, oxygen, and other substances as well as suitable ranges of temperature and light—that place is the organism's habitat.

The frog, for example, requires a wet, or at least a damp habitat. Its *range of tolerance* for water is narrow and thus limits it to such a place. A frog's thin skin makes it vulnerable to drying out, as does the jelly-like covering of frog eggs. The gill-breathing tadpoles could not survive more than a few minutes if they were not in water.

The frog, and every other animal and plant, has a built in range of tolerance for every factor of environment. If the changes in the environment exceed the organism's range of tolerance, death is inevitable.

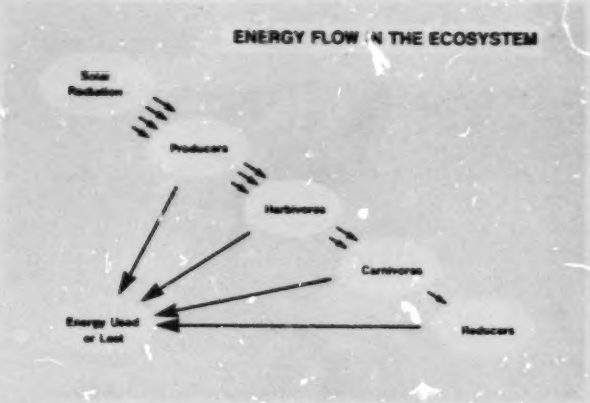

FIGURE 1. Life on the earth depends upon the continuous input of energy from the sun. The chart shows this energy flow. Energy is used or lost as heat energy in all life processes.

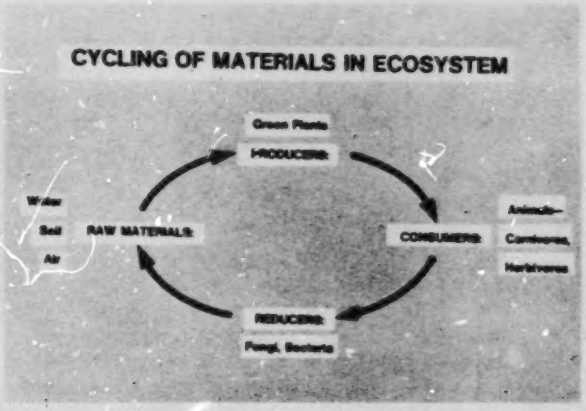

FIGURE 2. The earth is a closed system. No significant amount of material is added. Life can persist as long as essential materials are continually cycling through living systems.

For example, methods of food preservation are manipulations of the environment to extend some factor beyond the range of tolerance of undesirable organisms —bacteria and molds. Canning and freezing extend temperature ranges. Drying removes the water necessary to all life. Sealing prevents recontamination.

Within limits, plants and animals get what they need because of their ability to respond to events in the habitat. A bean seedling's stem and leaves bend toward the light and its roots grow in the direction of the water source. A rabbit runs from a fox, then crouches motionless under a bush while the fox rushes by. An earthworm will move away from a dry surface, but might stay on a wet surface. All of these responses have survival value.

Plants and animals respond to the day-night cycle and to the changing length of day through the seasons. In many cases, the causes of these responses are still unsolved puzzles. But they can be seen to have survival value. Our own sleep and wake periods are keyed to photoperiod. Man is by nature a daylight animal; he crawls into his cave and sleeps during the dark part of the day-night cycle.

Caterpillars of the polyphemous moth spin cocoons and enter the pupal stage in the fall while food is still abundant. Do they "know" what is ahead? Hardly! Experiments suggest they are responding to shortening day length. And what about migrations of birds? Many birds begin fall migrations long before dramatic weather changes occur, and some return to their breeding areas before the spring thaw. Temperature and food supply have to be ruled out as triggers of migration of all birds. Changes in day length seem to be stimulus for many.

Just as a plant or animal's capabilities limit it to a specific environment, so does the environment limit the kinds and numbers of plants and animals that live there. The desert will support cactus, but not pond lilies. The temperate forest will support maple trees, but not mahogany. Abandoned farm land might support briers, but not tulips.

When one thinks about the vast number of different environments that occur on earth, realizing that most of them support some kind of life, one cannot avoid being impressed by the tremendous diversity which exists. Think about matching the ranges of tolerance and behavioral responses of plants and animals with the diversity of environments. When an environment changes, most of the organisms may die. Other kinds move in with the few survivors, while other environments still support life. Perhaps this diversity explains why life has persisted on earth. Why, then are people worried? Why the environmental crisis? Because we are now capable of altering the environment beyond the ranges of tolerance for the human species—perhaps beyond the ranges of tolerance for all life. We are aware that we have made a good start at doing just that.

Populations of One Species

No plant or animal lives in isolation from others of its kind. Some species develop a well-organized social structure, others may simply coexist. Whatever their way of life, the organisms of one species, inhabiting an area, constitute a population.

Many kinds of plants and animals have the reproductive potential to cover the earth, but none has done it. What, then, determines how many individuals will survive? What prevents overproduction? or oversurvival? Darwin proposed food supply, disease, and predators as the prime regulators. Now we add selfregulating mechanisms to the list—social behavior and physiological responses.

A classic example of a population's response to environment is the white tailed deer. Around the turn of the century market hunting reduced deer herds to levels nearing extinction. In efforts to save the deer, predators

were slaughtered, game laws established limits of kill and protected does and fawns. While these conservation laws went into effect, the habitat was changing. Forests were lumbered and land was cleared for agriculture. Deer habitat was thus improved, but the cats and wolves were gone and only man remained as the predator. Deer populations grew, but so did the trees. Now, in many areas, essential woody browse is out of reach. The *carrying capacity* of the range is diminished. While we retain our protective laws, thousands of deer starve to death in late winter. Without sufficient predation, the surplus population is responding in another way to the changing environment—massive die-off.

Perhaps one of the greatest benefits to have evolved from game management research is the increasing attention given to population ecology. Statistical studies of animal populations are revealing growth patterns and levels of stability which are, of course, different for each species.

Among the social behaviors which seem to have regulatory function are the territorial habits of many animals. In a suburban area, or a city park, in spring, one may see male robins challenging each other—usually in the same place—a certain lawn or part of the street. Males defend territories by song, threats, or fights. The effect is to limit the broods to a number that can be supported in the area. The strongest birds breed, competition is reduced, and the young have greater chance of surviving to adulthood.

A variety of forms of social organization has been described among insects, fish, amphibians, reptiles, birds and mammals. Territoriality and dominance hierarchies are common and easily observed.

Reproductive behavior (courting, nesting, and care of young) becomes part of the function of organization in flocks and herds, the animals establish dominance hierarchies which contribute to defense against predators, serve to maintain peace within the group, and help to determine which animals reproduce.

Ethologists are reluctant to apply behavioral research discoveries to human individuals and societies. But the implications are there and it is difficult not to make comparisons.

Even from a conservative point of view, if one considers man as part of the continuum, it is reasonable to suppose that many of man's individual and social behavior patterns have their forerunners in other animal groups.

Although population ecologists still work on many unanswered questions, one generalization seems possible. For every species, there seems to be an optimum population density. Density increase or decrease triggers events which tend to return the population to the optimum. The migration of lemmings is one such case.

Some of the most important population questions, those related to human populations, remain unanswered, although inferences can be made. What is optimum population density for the human species? At what point (if any) will the stresses of urban living result in reduced birth rate? Indeed, do these stresses affect birth rate at all? Is the increase of organic disease a response to increased population density? Until we have answers, what should we be doing to relieve the obvious stresses?

Communities of Populations

A *biotic community* consists of a variety of populations living in the same habitat. Some of these plant and animal populations may be directly interdependent and some are associated only by their tolerance of the same environmental conditions.

Communities are usually named by the dominant plant (the largest or the most abundant) or by some dominant physical factor. Thus we can find reference to the beech-maple forest, the sphagnum bog, the cattail marsh, and desert. In recent years, students have investigated biotic communities in urban areas: vacant lots, lawns, and microhabitats such as cracks in walls and sidewalks.

Food relationships among plants and animals are the easiest to observe and understand. Everybody eats. Even the green plants which manufacture all the world's food consume some of it as they grow and use energy.

In every case, the familiar food chain (or better, food web) begins with green plants which are eaten by the herbivores, which are eaten by the carnivores. There are many species of herbivores in a community. In the pond, the snails, mayfly nymphs, all the small crustaceans (e.g. daphnia) and several species of fish feed on plants. Other aquatic insects, crustaceans, and fish prey on the herbivores and on each other. Feeding on these are all the parasites and scavengers.

The more different kinds of plants and animals at each food level, the more stable is the community. This is axiomatic and explains man's agricultural problems. Clearing a field for pasture or crops means removing a mixture of many kinds of plants and replacing it with one or a few. The result is the removal of small populations of many kinds of animals and the improvement of the habitat for large populations of few which thereupon become pests because they compete with man for a product which he needs.

The axiom then, is: *Diversity strengthens stability while uniformity encourages instability.*

The physical structure of communities is interesting to investigate. Everybody needs a place-to-be, and the greater the variety of plants, the greater the variety of places-to-be and the greater the variety of animals to be there. In a forest there are animals in the crowns of trees, in the knot holes on the trunk, in the shrubs, and in the soil.

Life is not static. Individual plants and animals have finite lives. They grow, reproduce, and die. Likewise communities are not static. They develop and change. Members of a community, by their very existence, tend to make the environment unfit for themselves, but fit for other plants and animals. Gradually, new associations are formed in the new environment, and a new

community emerges. This is known as *community succession*.

Pond succession is a good example. As the rooted and floating plants growing around the edges die off, their remains sink, the pond becomes shallower, more aquatic plants grow. Over the years the pond becomes increasingly shallow and gradually succeeds to a marsh. Cattails replace pond lilies and soon willows and other wet land shrubs get a start. The land becomes drier and finally marsh yields to meadow and meadow gives way to forest. How long this takes depends upon the climate and, of course, the amount of disturbance by the number of catastrophic events such as floods, tornados, or human intervention. But changes are inevitable. The eutrophication of large lakes that has been discussed in the past few years is a natural process of succession. The problem is that man has caused it to occur so rapidly that the lives of cities that depend on the lake are threatened.

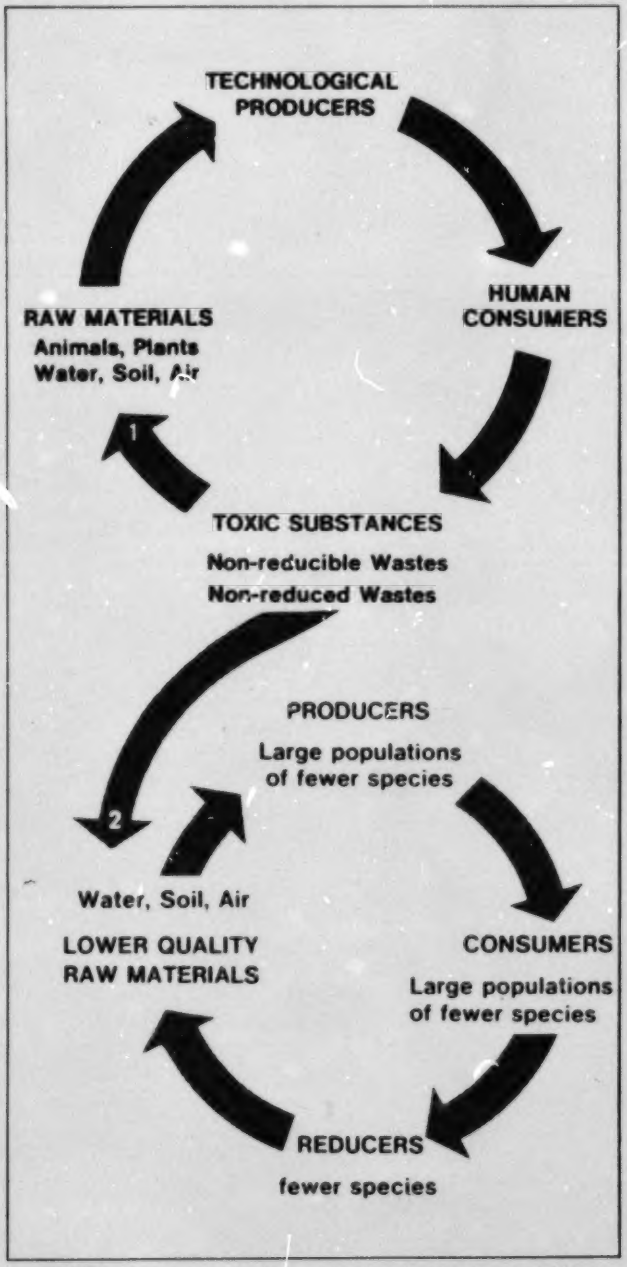

FIGURE 3. Because the earth is a closed system, toxic materials entering the living system may affect myriad forms of life. The arrow (1) in the diagram suggests that too few technological wastes are reused; thus lowering the quality of the raw materials. The arrow (2) to raw materials suggests a lower quality of raw materials cycled back into the natural system. Altering its quality reduces the number of species in each part of the system, threatening the system's stability.

Most of the ecologists' examples of biotic communities occur in rural wilderness areas. Does the city fit into the scheme?

The city can be compared to the cave community. All of the basic food, the plant products, are brought into the cave by commuters. Bats go out at night and eat insects which have been feeding on plants. While they rest, clinging to the roof of the cave, their droppings accumulate on the cave floor. Cave crickets feed on the fungus. Streams flowing through the cave bring a variety of plant products and animals which become part of the food supply of species confined to the cave.

The city, a man dominated community, actually includes many other kinds of plants and animals. The grass, shrubs, and trees of the parks and streets cannot supply enough food for the animals. Although man's food is shipped in and most of his garbage and wastes are hauled out, enough is dropped en route to maintain other animal populations.

Ecosystems

The definition of *ecosystem* is not unlike that of *biotic community*. However, when ecologists talk about the *ecosystem*, their discussion focuses more on energy flow and materials cycling than detailed descriptions of specific plant-animal groups.

The systems idea compels us to think schematically and *ecosystem* is a schematic way of describing the interlocking relationships among living organisms and environment.

Materials are the many elements in food and air. The energy originating with the sun is locked in chemical bonds by the plants. Some of it is dissipated as the food is eaten, digested, and converted into animal tissue several times over each time an eater is eaten. Eventually, all the energy of the original food is dissipated. The materials are again in a form available to plants which use energy to reform it into food.

And so the system, the ecosystem, will continue to operate dependably so long as there are diverse paths for the flow of materials and energy.

The system's operation is threatened, is less stable everytime a species of plant or animal becomes extinct or anytime a substance, toxic to an important link in the chain, is introduced into the system.

Here is the heart of our environmental crisis.

PART II: Ecology for the Child

A PEOPLE that wants to govern itself must educate itself. Likewise, a people that wishes to survive must think and act ecologically—must develop an ecologically valid value system. Teachers must help children develop ecological knowledge and awareness as well as constructive attitudes toward the environment.

All of us, children and adults, learn what we live. Our attitudes and our knowledge are acquired through experience. If we aim to help children toward ecological thinking, verbal experiences are not enough. Books and talk help support ideas, but the heart of the study must be direct experience with living plants and animals and with the environment. *The environment is the laboratory.*

Obviously, the first thing we all must do is monitor our own behavior. Children observe and mimic us. They learn our habits of waste, litter, and indifference. It matters if we pull leaves and small twigs from trees and shrubs as we walk through the park. It matters if we shoot a heron or a hawk while we are duck hunting. It matters if we throw the empty beer can over the side of the boat. When we make a decision in terms of a short term gain rather than long term benefits, children notice.

School experiences require more systematic planning. Environmental education programs are being planned and some have already been published. Most involve both the natural sciences and the social studies. Whatever their subject matter, the experiences which children have should be real. Children should have the opportunity to study real plants and animals, real environments both natural and man made.

Awareness of man's impact on the environment may be an important step toward minimizing destructive action. Through tabulating reports of births and deaths in their own towns, children can become aware of population increases. Understanding the inefficiencies of our modes of transportation can be achieved by counting cars and passengers at any intersection during commuting hours. Over 50 percent of the cars are transporting only the driver.

Picking up litter can be a futile task unless it leads to awareness and positive action. Are there enough trash containers in the right places? What happens to the dead leaves in the fall? Can the children compost them for later use on school-site plantings? What kinds of cleaning compounds does the school system use? Is the school's trash separated so that waste paper can be baled and sold for recycling? Can adults and children help the community develop a glass collection system? Do the children realize that cities are running out of places to dump trash—that this is the immediate reason for quick action? What other reasons are there?

Adapt Traditional Activities

Many of the traditional science activities need only changes in emphasis to adapt them to an ecology centered program. One needs to ask the question to point attention toward the key concepts of interaction and change. Questions such as:

—Almost all house plants originated in the tropics. Which came from the dry tropics? Which from the wet tropics? How do you know?

—The praying mantis is eating a grasshopper. What did the grasshopper eat? How can you find out?

—Expose some bean seedlings to more light than others. Which are greener? Which grow faster?

—Are the ones which grow taller the fastest, the same ones that become greener?

Keeping plants and animals alive in the classroom is in itself an ecological challenge. Most classrooms are too hot or too cold, or both.

They may be too sunny or too dark and almost universally, they are too dry. Plants and animals alike suffer the shock of rapid temperature changes and loss of water. Teachers and children become discouraged and as other demands crowd in, efforts to keep live plants and animals are abandoned.

The ideal way to solve the problem is to construct or purchase an enclosure with its own light source. The glass or Plexiglass walls reduce water loss and moderate temperature changes. The artificial light overcomes the problems of short days and cloudy weather. An inexpensive clock switch permits experiments with varying photoperiods.

A more temporary solution is the plastic bag.[1] Each child has his own plastic bag greenhouse which is quite satisfactory for small plants.

The alternative to having these small vivariums in the classroom is vigilance and selecting live study materials which have wide ranges of tolerance. Let the problem become an ecology project.

Visits to zoos and arboretums can supplement classroom study. What must zoo curators in St. Louis and Washington do to keep tropical animals alive? How do polar bears fare during the summer months? Why are there no koalas in zoos outside of Australia? The doors of the greenhouse rooms of the arboretum may be kept closed. *Feel* the differences of temperature and humidity as you walk from one room to another. Look at the textures of the plants. Talk about relationships between the plants and their habitats. Ask the curators to explain how they maintain plants and animals from other climates. Curators are practical ecologists.

The key to a good trip to the zoo or arboretum is planning. Since it is not possible to study the whole area, concentrate on one part of it. Let the guide or curator know, in advance, the preparation which children have made and the questions they want to pursue.

Weather studies take many forms, but they occur in nearly every classroom at some time during the school year. The interacting factors involved in creating weather offer an abundance of opportunity to study interrelationships.

One question leads to the other. What interactions result in wind? Wind blows (air moves) from high pressure areas to low pressure areas. What causes these *high's* and *low's*? Temperature differences, perhaps, or humidity differences, or both. What causes temperature differences, moving air masses or unequal heating of the earth? Heat and moisture affect the air and its behavior.

How do people react to weather changes? Keep a daily record of your mood or how you feel—peppy or lazy, friendly or grouchy. Keep a record also of the weather, rainy or clear, humid or dry, cold or hot. Compare the two records. Does the weather affect how you feel?

Which of the old "wise sayings" about the weather have validity? Children can record daily weather data or get it from newspapers, radio, and television. What then? One group of students superimposed line graphs of daily high and low temperatures on a graph showing number of hours of daylight. The record extended from October through February. It was easy to see that temperature trends lagged behind the daylength changes. That is, the shortest day was not the coldest. The coldest weather occurred in mid-January, a few weeks after the days had begun to lengthen.

Many other kinds of graphic summaries are possible. For example, compare temperature of two cities on the same latitude, or two cities on the same longitude. Relate temperature differences to topography as well as to latitudinal or longitudinal location and relate all this to plants and animals in the region, clothes people wear, food they eat, and building materials of houses.

Changes in the length and direction of a shadow are evidence of the changing earth-sun position relationship. Changes from hour to hour during one day or from day to day at the same time can be measured. Is sun-noon at 12 o'clock where you live? A shadow record will help you find out. Only twice a year does the sun rise directly in the east. Where does it rise on other days?

When children see an unfamiliar animal, they want to know: Will it bite? What does it eat? This is an invitation to pursue the interesting question, "How does it make a living?" Now we are studying ecology. Does the animal's reactions to light and dark, wet and dry, heat and cold, offer clues to explain why it can survive in its habitat? Ask these and other questions about familiar animals—the earthworm, the cricket, the mouse, or the robin. In a sense, the laboratory experience is a way of "asking" *the animal* the question.

Ask questions about plants too. Dandelion's way of life must be exceedingly successful. The evidence is that there are so many dandelions living in so many different kinds of places. The challenge is to investigate dandelion's form and habit to find clues to its success. That is, "Ask" the dandelion.

These are a few isolated examples of ways we can adapt some of the activities of the older programs to new programs with new goals. It is accomplished by asking new questions and by answering the questions through observing, keeping records and summarizing the data.

Almost certainly, environmental awareness will grow if, in all of their investigations, children are looking for interrelationships, changes, and effects of changes. As cities grow, children have fewer opportunities to explore different kinds of habitats and to see the origins of their meat and vegetables. Zoos, arboretums, nature centers, and school camps become more important. Even a small plot of unpaved earth on the school site can become a living laboratory. The example of the Madison Elementary School in Washington, D. C.,[2] might well be followed by other school groups that have to work in the dreary environment offered by the old buildings of so many city schools.

[1] See the article "Windowsill Greenhouse" by Sylvester G. March, *Science and Children*, November 1966, page 15.

[2] See "An Urban ESA," by Sylvia K. Shugrue, *Science and Children*, January/February 1971, page 21.

Earth Science Experiences: Expanding the Child's Awareness of His Natural Physical Environment

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EARTH science is a field-oriented discipline. The content of the earth sciences, the materials and processes of the natural environment, cannot be understood solely through vicarious experiences in classroom or laboratory. Field study is required at all levels of instruction.

In the elementary school, many science curricula have been developed for classroom-laboratory instruction that are consistent with a new understanding of the intellectual development of children. In this paper, we will attempt to develop a model for field-oriented activities in earth science, which as far as we know has not yet been attempted. The site model described herein also has potential for use at higher educational levels, including teacher preparation.

Field Trip *vs* Site Model

Field work is not usually the major emphasis in earth-science courses for teachers-in-training. Where field experiences are employed they usually follow a traditional field-trip pattern: The students are transported to several distant areas where, at short stops, they are expected to demonstrate an unreasonably high level of professional competence in observing and interpreting natural phenomena while at the same time hearing a lecture explanation. The few elementary teachers who later make use of field experiences in earth science tend to follow this methodology—*they teach as they were taught*. Such field-trip procedures and expectations are of debatable value in earth-science teaching at the college level. For the elementary school such field-trip methods are inconsistent with the manner in which science is related to the intellectual development of children.

Concepts and relationships represent abstractions based on observations of nature over a long period of time. These abstractions constitute the present content of any science. For young children, interaction with their environment provides accumulated experience that enhances the transition of their thinking from the concrete to the abstract levels (1).* This concrete stage of development, occurring between ages 5 and 10, is characterized by Piaget (2) as that time during which children can perform the operations of classifying, ordering, recognizing, and using space-time relations, etc., on objects. They cannot yet do this with verbally expressed hypotheses. The environment that provides the opportunity for elementary school children to actively explore reality through activities which are consistent with their

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* See References.

intellectual development is not provided in the typical field trip.

In contrast with the negative characteristics of the traditional field-trip model (middle, Table 1), consider the advantages of a *site model* for field experiences with elementary school children. The characteristics of the site model are detailed on the right side of Table 1. Emphasis in the site model is directed toward activities in local, easily accessible outdoor areas that allow the student to investigate contemporaneous changes in earth materials over a period of time.

Categories of Site Experiences

The dynamics of contemporaneous or recent surficial change on the earth can be categorized by reference to interactions that take place among the atmosphere, lithosphere, and hydrosphere. A range of practical site experiences is provided by some of the earth science features and phenomena caused by interactions among these earth spheres. The lithosphere-biosphere interaction offers a fourth category of site experiences. An individual site experience might constitute the entire content of the field experience or might be combined with other site experiences to form a sequence. A partial listing of broad categories of suggested site experiences follows:

I. Site experiences based on atmosphere-lithosphere interactions
   A. Weathering
      1. weathering of bedrock
      2. formation of soil horizon
      3. frost heaving in soil and frost wedging in bedrock
   B. Mass Wasting
      1. downslope movement of rock masses (rock fall, rock slide)
      2. downslope movement of soil (creep, earthflow, mudflow)

Biosphere-lithosphere interaction shown by mechanical smoothing of a sandy beach.

TABLE 1.

Comparison of Earth-Science Field Experiences

Characteristics	Traditional Trip	Site Model
LOCATION	relatively long distance away requiring travel time	walking distance from school
ACCESSIBILITY	single visit	convenient for frequent visits
	large territories	small, well-defined areas
OPERATION AND ACTIVITIES	time limits	no strong time limits
	instructor lectures to review and confirm prior knowledge	student investigations
	limited numbers of measurements and data recording	variety of measurement and continuous observations
OBSERVATIONS	emphasis on vast land and time spans	recent events considered
	concern about past, primarily internal changes in the earth	concern for contemporaneous, primarily surficial processes of change in the earth
	man's effect on the environment not strongly considered	actively considers man's role in environmental changes

   C. Erosion and Deposition
      1. sandblasting and removal of rock and soil by wind
      2. formation of dunes by wind
      3. soil erosion by rainfall

II. Site experiences based on hydrosphere-lithosphere interactions
   A. Streams
      1. erosion of soil and bedrock from walls and floor of stream valley
      2. deposition of stream sediment to form flood plains, deltas, etc.
      3. springs discharging ground water into streams
   B. Glaciers
      1. erosion of bedrock to form glacial polish and grooves
      2. deposition of transported soil to form terminal moraines, outwash plains, etc.
   C. Waves and Tides
      1. wave erosion of sea cliffs
      2. wave erosion and deposition of beach sediment
      3. currents in inlets generated by tidal rise and fall

III. Site experiences based on atmosphere-hydrosphere interactions
      1. wave generation in ponds, lakes, etc., caused by wind
      2. ice formation and seasonal overturning of lakes, etc.
      3. water level changes and surface currents caused by barometric pressure changes and wind

IV. Site experiences based on lithosphere-biosphere interactions
    1. chemical and physical attack by plants on rock and soil
    2. soil erosion and slope stability influenced by plants
    3. soil structure, porosity, and permeability influenced by worms and burrowing organisms
    4. soil and rock changes caused by man's construction activities

Selected aspects of rock structure and lithology that illustrate the role of internal forces in shaping the earth might be included in site experiences that emphasize contemporaneous or recent surficial change on the earth. When a part of a site experience, such relics of earth history as folds, faults, or fossils may provide many opportunities for the student to use some of the higher order process skills of inferring, hypothesizing, and model building.

Implementing the Site Model

Interactions among the atmosphere, lithosphere, hydrosphere, and biosphere provide a variety of environmental possibilities in which to apply the site model. These environmental possibilities exist not only in suburban or rural areas, but also in highly urban centers. Although the relatively few available site areas in cities limit the choice of field experiences, they also guarantee that such experiences, when properly developed, will be used by many generations of teachers and students. Furthermore, such experiences have the potential of counteracting the negative value system so often attached to science teaching in the cities (3).

Trial Unit Undertaken

A study of the problems of using earth science field experiences in the highly urban environment of New York City was undertaken as an outgrowth of a project to train elementary school science specialists. It became obvious that increased use of the field environment demanded local solutions which gave the individual teacher confidence in his ability to function in the natural environment around his school. After an intensive survey of selected school locations and open spaces in New York City, these criteria were established for recognizing and using urban sites for earth-science experiences:

1. Location within walking distance of the elementary school
2. Safety from natural or man-made hazards
3. Simple illustration of one or more useful earth science concepts
4. Potential for revisitation by teachers and students to observe natural changes

Of slightly less importance in site selection are the secondary criteria of:

1. Sufficiently large site area to allow simultaneous involvement of many students in the same learning task
2. Sufficiently large volume of earth materials so that samples can be removed by many student groups for further analysis
3. Presence of a variety of soil, sediment, rock, or structural interrelationships
4. Closeness to public water fountains and restrooms

In the initial study several areas in upper Manhattan that met the primary and secondary criteria were selected by the investigators, who visited and revisited each field area and recorded it on tape and film.

Following these examinations, an inventory of the earth science content was made for each field area and cross-correlated between areas. With such specific data, one could utilize the minimum field territory to see the maximum amount of each earth science concept. Each of the sites exhibited all or almost all of the following earth science features or phenomena: bedrock, fault, fold, dike, vein, differential weathering, glacial boulder or erratic, transported soil, stream drainage pattern, soil erosion, sediment, and mass wasting. The specific locations within each site where given geologic features or phenomena were especially well shown were identified.

The site model would have been satisfied by simply describing the site and specifying the exact locations that were of interest within each site. Indeed, such an inventory, if published as a field guide for the teacher completely untrained in earth science, would be adequate to the needs of all but upper elementary school teachers. A field guide to earth science sites would be of greater use to upper elementary school teachers if the locations were sequenced within each site so that there could be a smooth traffic flow in moving from location to location; where possible, alternative locations could be chosen so that a logic of progressively more difficult earth science concepts would be visited. Trial runs with elementary school teachers suggest that in order to be most useful for self-guided visits by untrained teachers and their students, site descriptions prepared by science specialists or curriculum writers should contain:

1. A keyword index to earth-science concepts or phenomena shown at locations within the site
2. Combined street map and site map showing position of each location (stop) at the site
3. Advance summary of earth science content of the site
4. Expanded description of each location including:
    a. Directions for reaching the location from the previous location
    b. Background information needed to understand the significance of what is being viewed
    c. Photograph with appropriate arrows or other labeling, taken from the exact spot where the teacher would be standing
    d. List of suggested activities that might be useful to perform with students at that location
    e. List of equipment needed to perform suggested activities *

* A handbook written in accordance with the above criteria has been prepared by the writers and is in press (4).

Atmosphere-lithosphere interaction shown by a weathered bedrock surface. Student teachers in foreground study written site descriptions.

Summary

The site model makes the local, easily accessible outdoor area part of the total learning environment of the school. It is based on a synthesis of those principles of learning which have guided other elementary science programs such as the AAAS, ESS, and SCIS. Specifically, the site model is developed to enhance those skills basic to further learning. Activities within the site provide the student opportunity to observe, measure, recognize and use space-time relations, and classify. He can communicate the information he acquires in a variety of ways including reports, graphs, charts, sketches, and maps. The more complex process skills of inferring, predicting, and interpreting data are also provided in the activities.

Hydrosphere-lithosphere interaction shown by stream meandering across a floodplain.

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earth science with a FOCUS on the child's environment

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TO educate is to encourage and to interest. For many children school is not encouraging or interesting; it is discouraging and boring. This atmosphere confronts them year after year until many drop out, either mentally or physically. They may express the thought that school, especially what happens in science class, is not relevant to their lives. But science can be both encouraging and interesting, especially when the focus is on the interaction of materials and objects that lie within an environment familiar to the child.

Children respond to a teacher who is interested, listens, recognizes the role of the environment in the child's development, and provides multiple opportunities for the self concept of the child to be developed: in short, affective learning. Children can reason, interpret, invent, discover, and create; but they must first be given the opportunity to develop these and many other talents they possess. This opportunity does not exist when science is presented as an organized group of facts.

This is not to say that facts should be omitted or circumvented while teaching; however, they need not be the sole objective of science teaching. Children should be given opportunities to inquire and discover science within a meaningful perspective. The "facts" will eventually be obtained, and the "concepts"

eventually learned. A child will gain an understanding of science concepts much more rapidly if he is focused on situations that are relevant, part of his perceived world and past experiences. From this, the child can develop concepts related to science. The life environment of the child—the real world—can furnish the teacher with relevant structures, a proper perspective, an opportunity for inquiry, and a focal point for an extension of experiences related to science.

At first most children feel strange studying things they think they "know." After a few preliminary observations, the students find they did not know everything about simple things such as the school, the sidewalk, or the playground. An imaginative teacher can introduce the children to a multitude of new realms all within the physical boundaries of the school. Some suggested activities are described below.

Before visiting the playground and the sidewalk with the class, however, it is very helpful to review some of the principles and concepts of earth science. For specific concepts, any introductory text in geology, astronomy, or meteorology would serve the purpose. Application of these ideas to a study of the child's environment is where the emphasis should be placed. After the concepts are understood by the student, generalization to the larger scope of earth science is possible. Several writers have also provided an excellent introduction for a teacher considering utilization of the environment for the study of earth science.*

Remember the students are the observers, recorders, and experimenters; the teacher focuses their attention on specific aspects of the environment. New activities and units focusing on situations unique to individual locations can be developed as teachers and students continue using this approach to learning.

Observing a Small Portion Of the Environment

What would it be like to be very tiny and live on the playground? How many things do you think you would see in a day? Through discussion, focus the students on the idea they are going to observe a part of their environment very closely. After going outside, each one can mark off a small portion of their environment; this should be an area of their choice but the average size is about two square feet. While the students observe the area closely and intently for ten or fifteen minutes, they should be considering such questions as *How would you describe this environment to a blind person? What is the smallest thing in the area? What is the largest? How would the area change if it rained? Did the area change during the time of observation?*

During the students' discussion of their observations, allow them to explain exactly what they saw, recorded, and observed. This qualitative observation activity could be escalated the next day utilizing rulers, meter sticks, and stop watches for quantifying observations. Some students may wish to map their areas; if so, the concepts related to scale can be introduced. The students should be allowed to structure their study as much as possible. Self direction is learned through opportunities and experiences in self direction.

Investigating Change

Take the children on a walk around the school, both indoors and outdoors. As they focus their attention on change this time, they might ask themselves: *Is there something in the classroom that is different than it was yesterday? Is there something that has not changed since yesterday? What has changed since the school building was constructed? What is the evidence for change? What objects interacted to produce change?* Observations of chipped paint, worn stairs, cracks in the wall, weathered brick, or broken windows could be cited. *What changes were caused by people? By nature? What changes do you feel were good? Bad?*

During the post-trip discussion, the children can talk about ways to define change. Introduce the elements of scale and time. *What will change today? In a week? In a season? A year?*

After making their observations the students realized they did not know everything about simple things such as sidewalks, streets, and the playground.

* See References.

What causes change? Could these same types of changes occur elsewhere in nature? How? A good extension of the experience is gained by having the students actually change pieces of earth material, preferably pieces they have collected.

Relative Age of Materials

The fundamental geologic principle involved in this activity is superposition. In a series of materials sequentially deposited, materials on the bottom are the oldest; thus, a sequence of relative ages can be established for deposited materials (two examples are sedimentary rock and the mailbox after vacation). A fundamental understanding of superposition can be developed by first having the students close their eyes or lay their heads on their desks. While they are not looking, drop several books one at a time on top of each other. When the students see the pile of books ask, *Which book did I drop first? Second? Last? How do you know?* The concept of correlation can be introduced using two stacks of books side by side in matching layers. The sets can be modified to introduce the concepts of omission or unconformity. The effectiveness of this demonstration is in its simplicity.

During a subsequent class period, take the class on a walk to a nearby area. Choose a section, or several sections depending on the size of the group, preferably including a sidewalk and a parking lot or driveway. Try to find an area where the street has been patched or repaired. (Safety should be considered in choosing the sites.) The students can rank all the materials in their section according to relative age, applying what they know about superposition. The concept of correlation may also be introduced where portions of cracks have been patched. *Could you correlate the cracks from one side of the patch to the other? What is the relative age of sand in the gutter? Was the curb placed before or after the street was? What evidence do you have for your answer?* In the post-trip discussion, students can suggest ways to resolve any questions not fully answered by the discussion.

Movements of the Sidewalk

This field trip, taken within walking distance of the school, can be completed during one or two class periods depending on student interest. The focus is on movements of the "earth's" surface, in this case the sidewalk, street, or school yard. The understanding of concepts related to folding, faulting, and fracturing are the objectives. Locate a portion of the sidewalk that has been subject to a deforming stress. Observe the direction of cracks in the street and see if the children can connect the direction of cracks with a specific cause.

How did the sidewalk move? How much has the material been displaced? Which section was pushed up? Down? What would this section look like from the side? Can you draw a diagram of the movement? What caused the movement? Did the sidewalk break? Where did the break occur?

This activity can be extended by recording measurements and returning several months later to measure again to see if there has been any more movement. Mapping of the area and precise description, including the direction of movement, can also be incorporated in the children's work.

Erosion and Deposition

This is an easy carryover from the field trip investigating the street. When children notice sand, stones, and other material that has been deposited in the gutter, they may form some hypothesis about the deposition of material. *Where is material deposited? Why is it deposited?* Through discussion, develop the idea that where the energy of the stream becomes inadequate to carry the sand, etc., further, it will be deposited. Thus, the relatively low areas (puddles, ponds, and lakes), behind plants and in cracks are places where deposition occurs.

Ask the custodian to place a hose on the school grounds where water can flow into the gutter, so that the students can study the water and materials being carried by the water. This activity can demonstrate some of the ideas the students generated during the observation portion of the investigation.

What materials are carried in the water? Where did they come from and where do they go? How large are the particles? What determines the size of something carried by the water? Where and why are earth materials sometimes deposited by water? As a summary to this lesson, the children can discuss: *What is erosion? Deposition? What is a possible sequence of weathering, erosion, and deposition in your block? Where else on earth do you think these principles could be applied?*

The History of a Vacant Lot

Before the students go to study a vacant lot, they should know that the result of their study will be the development of a history for the lot. The students themselves should decide how they are going to study the vacant lot.

Concepts already developed in the other examples, such as superposition and correlation, will be helpful in their study. As the need arises, the teacher can remind the students of these concepts. Be sure the students keep a record of materials collected, their location, position, and depth. This investigation might also include making a map of the area that is in more detail than the earlier mapping activity.

Finally, have the students infer a possible history of the lot based on their observations. Based on what they have observed, have them imagine it is ten thousand years from now and they just uncovered the area. *What can you infer about our*

civilization? What about the last ten thousand years? Has the lot changed? How?

Using a Focus Word for Observing

Once the children have made a few of these discoveries about their environment, it is occasionally fun to give them only a focus word for their observations. Words such as: survival, harmony, systems and subsystems, like and dislike, interdependence, color, concordance, repetition, variation, change, polluted, clean, and balance are only a few that might be used. There are other ideas for focusing on the environment such as the evolution of a city, water cycle in the city, weather in the city, and micro-weather in the school yard.

If the question "How do children learn science?" is extended to include "How will children continue to learn science?" the answer is not found in a response of presenting them with a systematic body of facts about science. Increase their interest in science, overcome their fear of failing, and allow them for a while to study their physical environment. Science certainly is not a lecture or reading a textbook; it is being involved, experimenting, manipulating, discussing, and in one word, *doing*. A new theory, facts, or rearrangement of some present knowledge may result. Many teachers would counter this argument with "But the scientists have a body of facts when they start." My answer is—*so does the young child*. Find the knowledge the child has, extend his experience in a positive way, and focus his attention on new experiences within his environment.

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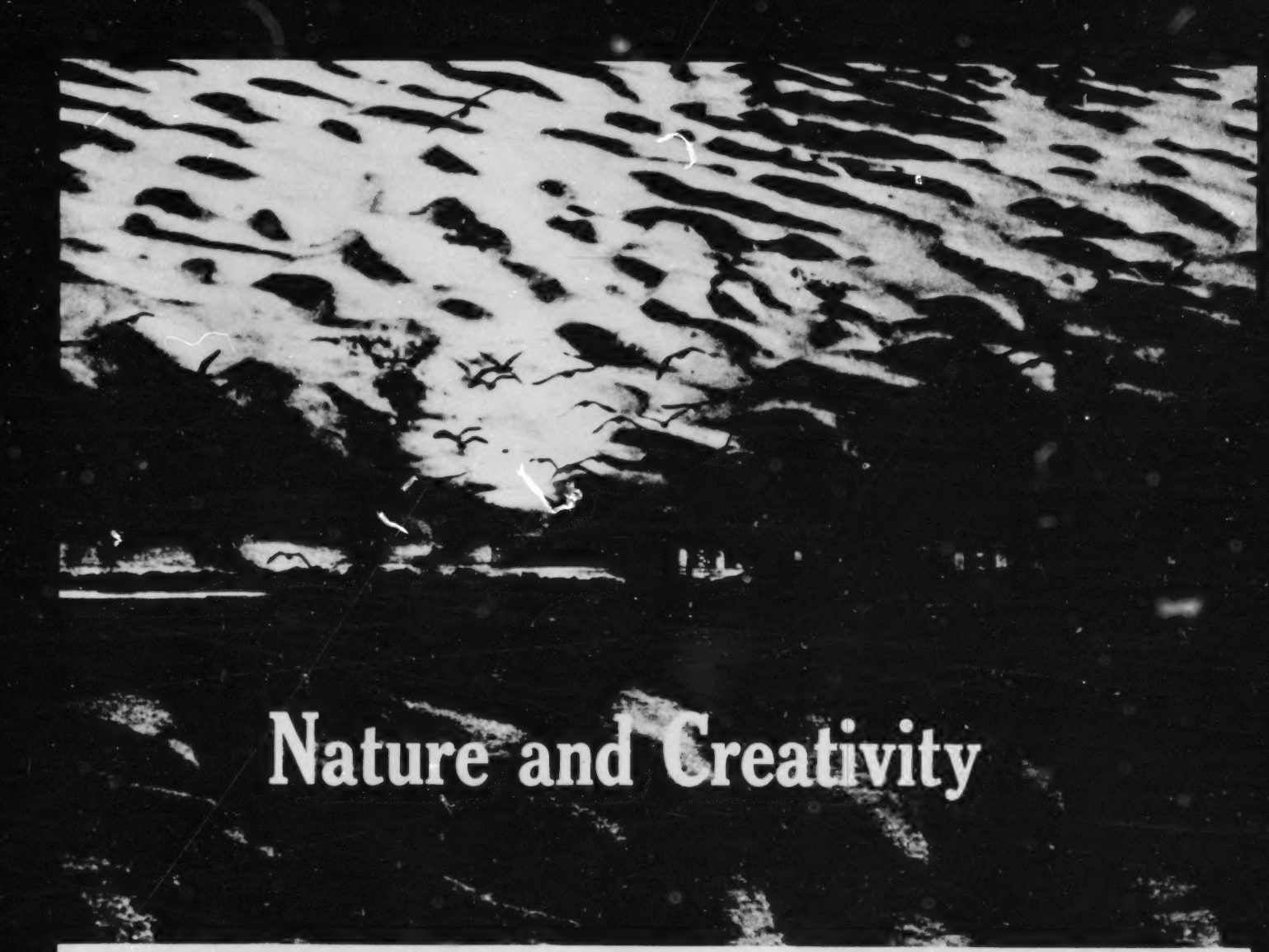

Nature and Creativity

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WITH urbanity closing hard on the wild places, many conservationists are concerned enough that the phrases "balance of nature" and "wise use" have become familiar to more people than ever before. Many eloquent arguments have been put forth in efforts to cite reasons for the preservation of nature, but too few are heard. However, there rises from all aspects of American society the cry for creative minds to meet the challenges of modern civilization. Upon the surface, little seems apparent to relate nature and creativity. However, much research in the past several years has linked creativity and nature in a way that demands consideration by modern man.

What is creativity? Definitions abound, yet certain commonalities exist. Most concepts of creativity and creative thinking embody openness in thought process, a kind of freedom to ramble mentally and make associations that have gone undiscovered. The inhibitors of creative thinking are myriad. Nearly all of the structured frameworks of knowledge and behavior that have been perceived by man's mind are guilty of setting standards of conformity. And conformity to standards, by definition, requires a lack of freedom in association of ideas.

This, perhaps, is the reason for the tremendous clamor for creativity at the present time. Our society has developed such a host of conformity patterns that man's adherence to them has limited his ability to think creatively. Minds have learned to focus and converge, rather than extend and diverge.

Why? It is all too easy to blame societal patterns for these conformities, and many have done so. But perhaps society as an institution is not as guilty as society as an organism. By this, it is suggested that urbanity, as an amoeba-like entity which in process tends to feed upon itself, is really the villain.

Let us consider the growing city of today. As the

suburbs are cast sporelike out of the metropolitan centers, they germinate and are eventually welded to the parent city. Certain environmental conditions exist that favor one city over others, so that city's urban advantage allows it to conquer others. Eventually, megalopolis develops. Individual indentities are lost. Since urban areas appear to those in them self supporting, interchange between the urban and rural becomes an abstraction to most members of the urban society. The world of nature is restricted to parks, aquaria, zoos, and, sometimes, "the country." The urban people have, however, access to the best in cultural opportunities—galleries, [illegible]ns, concert halls, libraries, and the like. They also have tremendously advantageous educational opportunities. Their needs are met by their urban environment. And yet, in the glittering canyons of urbanity, there rings loudly the cry for creativity.

Why is it that the need is so apparent today? Is it that man has achieved such control of his environment that the gentle nuances of nature no longer are noticed, but only the catastrophic and devastational? Is it that in the urban creations, the buildings are beginning to look too much alike, and the new autos, though elegant, are difficult to distinguish from one another? With all its advantages, where has urbis gone wrong?

One answer might well lie in the completeness with which urban society has divorced itself from nature and the natural. William J. J. Gordon points up the role of the commonplace as a reservoir for elements of our thought processes:

> Highly trained technical people often think in terms of the immutable validity of their own special technology. They resist twisting their conventions out of phase. . . . Conventions as abstractions from reality constitute a virtually complete and unassailable pattern, whereas the commonplace is infinitely repatternable. . . . there is built into the human mind a resistance to the study of the commonplace.[1]

Dr. Gordon goes on to suggest that the best way to overcome this resistance is through the use of the metaphor. Metaphor is a comparison that provides insight into similarities between often dissimilar elements of one's environment. By recognizing such relationships, one is thrust into the role of examination of the commonplace and may well be indulging in creative thought.

Assuming that through the process of metaphor, creative thought is attainable, what is the relationship between creativity and physical nature? The answer lies in the essential character of the metaphors available to the person bent on indulging in creative thought. The processes of urbanization create a host of elements in the commonplace world that are several generations removed from the world of nature. These elements have been mediated by countless minds and hammered into the abstract forms of urban society. To the mind growing amid these forms, the sources of metaphors are the already derived and mediated objects of urban evolution. Though utilitarian, perhaps these objects are capable of evoking only more channeled kinds of metaphors. They would be, in fact, "conventional" metaphors.

The world of physical nature, on the other hand, is not derived or mediated; it is "natural." The metaphors of nature are those which originally inspired all that is urban society. The metaphors available from nature are infinite and, as such, do not have the built-in limitations of the artificial abstractions so fundamental to the urban elements.

Young people entering colleges and universities today are primarily products of urban areas and the urban society spawned by them. They are bringing with them a heritage of thought elicited by urbanity and the second- or third-generation metaphors attendant to such a background. To these young people, something is "as slow as a model-A," rather than "as slow as a tortoise." (It's a pity, for, in its devious way, the tortoise generated, knowingly or not, ideas fundamental to certain design elements of all automobiles.)

Fundamentally then, the relationship between creativity and nature is entrenched in the metaphor. Biological metaphors provide man with an array of alternative relationships that is diminished each time ideas are abstracted and removed in form from their natural origins. To put it simply, the stately temple of creative thinking is more easily built from natural metaphors than from derived metaphors because there are more of the former.

If young people (and society in general) are insulated from nature by concentric layers of urbanity, then the quantity as well as quality of creative thought might be expected to diminish. The Thoreaus of the future could not exist, for there would be not one to write:

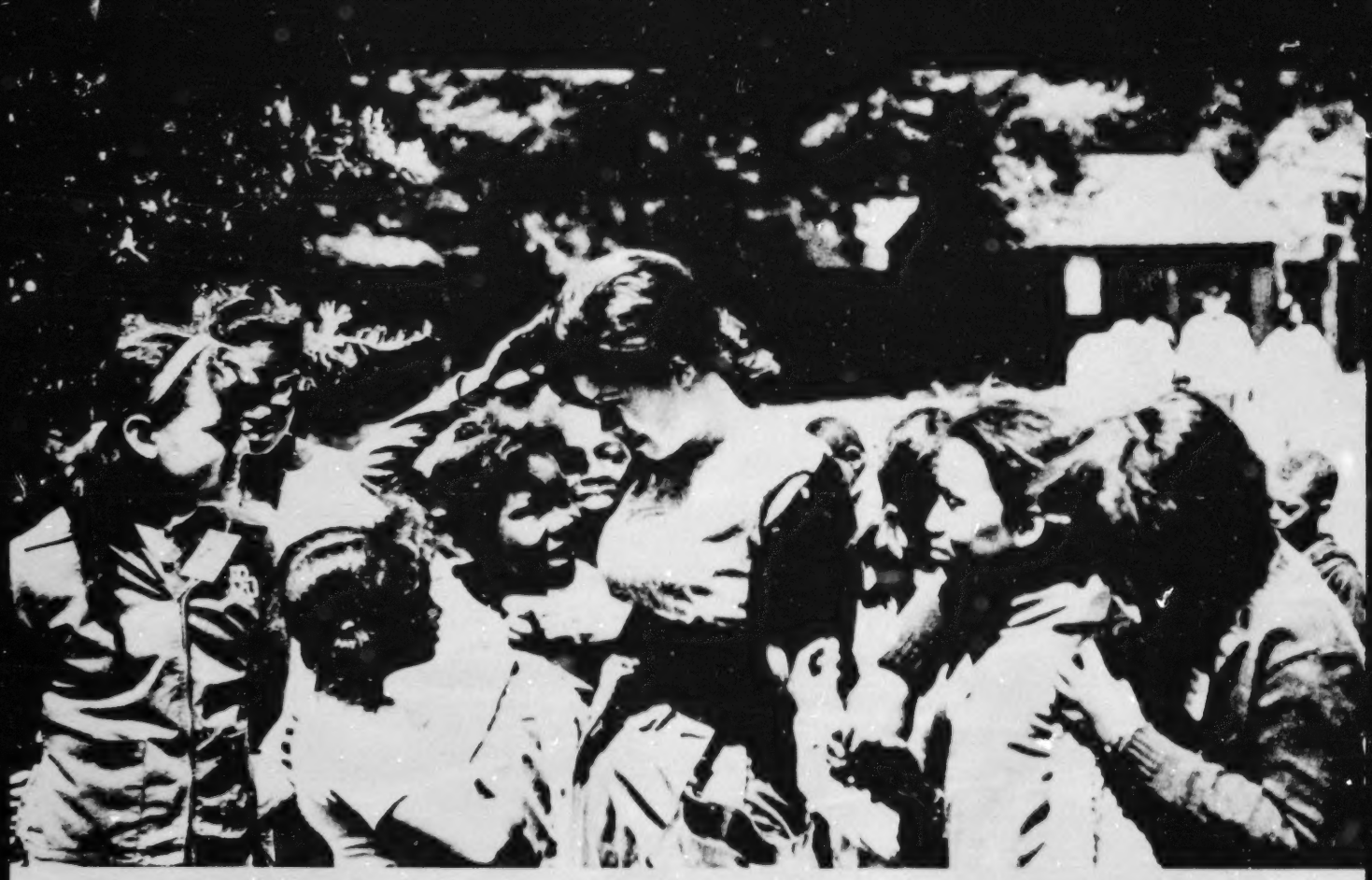
> Every tree, shrub and spire of grass, that could raise its head above the snow, was covered with a dense ice foliage, answering as it were, leaf for leaf to its summer dress . . . these ghost leaves, and the green ones whose forms they assume, were creatures of the same law; the vegetable juices swell gradually into the perfect leaf on the one hand, and the crystalline particles troop to their standards in the same order on the other.[2]

Education is but part of the task, for tomorrow's teachers must be able to provide the natural for students. If nature and the natural are allowed to expire in the face of the urban onslaught, then creative potential in future minds might well be affected. This then should be considered as another of the many reasons for preservation as well as conservation.

Mankind has an affiliation with nature that might well be severed in the realm of the commonplace. An obligation far above sentimentality exists for man to perserve this reservoir of creative alternatives.

[1] Gordon, William J. J. *Synectics*. Harpers, New York City, 1961. p. 105.

[2] Thoreau, Henry David. *Walden*.



The *Conceptual* Field Trip

"I have a leaf just like hers, but mine is an example of change in living things, and hers is an example of dependence among living things. Somehow they seem to be related." Indeed they were. For the rhododendron leaves the children collected both showed change. One of the children simply looked a little more closely and had noted that the change in the color and appearance of the leaf had been caused by an insect—a leaf miner dependent on the leaf for food and a home during its larval stage. These sixth graders from the Seth Lewelling School in Milwaukie, Oregon, spending a week at Camp Westwind on the beautiful Oregon coastal dunes, were developing concepts of science, concepts of environment, and concepts of conservation.

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SINCE educators first directed their attention to the idea of helping children develop concepts rather than filling their minds with facts, the "concepts" approach has found general acceptance. Textbooks, elementary science projects, and more recently, a series of teachers' curriculum guides for conservation education have been developed under the South Carolina Curriculum Improvement Project using the same concepts.* Even so, in the field, teachers still stuff their pupils with facts. So, too, do some interpretive naturalists in the park and forest programs for the public go in for the "whole load approach." A teacher, forester, or park naturalist may take a group out into the field and proceed to tell the children numerous facts he has learned during his formal education and in his work experience since, in a period of one hour or less.

At some resident outdoor education programs, the children get the "whole load" on a different area of science every day (sometimes two a day). On a trip through a National Park or National Forest, the child or visitor may be exposed to all about the geology, soils, plants, animals, and the type of conservation which the managing agency practices on the area. The result is that children in school and summer tourists are environmentally illiterate—they have no concepts of environment and particularly their own interdependence with the environment.

* Brennan, Matthew J., Editor. *People and Their Environment*, Teachers Curriculum Guides to Conservation Education. J. G. Ferguson Company, Chicago, Illinois. 1969.

If the conceptual approach is acceptable for textbooks, teachers' guides, and media materials, why not try it for teaching and learning in the field—in the natural science laboratory? A "conceptual field trip," can be used effectively, lasting 5 to 10 minutes, offering a child acquaintance with a single concept of environment. In this way, rather than the "whole load" the teacher can present to the class a sequentially planned series of field experiences which will lead to development of several concepts of environment.

In an analysis of the "whole load" presentation of several foresters, explaining the reasons for block cutting of Douglas fir, black walnut, or cherry, why not prepare a list of the concepts they briefly mention: germination on mineral soil, response to sunlight, tolerance to shade, effects of crowding, thinning. These concepts can be better developed in a planned elementary science sequence, rather than through a unit taught a day or longer.

For example, at The Pinchot Institute, many interesting field trips are taken with children at all levels. With kindergartners, the Institute has had great success with a ten-minute trip to see three trees. One is big and tall and straight, the forester's dream tree. The second is a hemlock that blew down in a storm several years ago. Its roots are still intact and the tip has turned up toward the sun. (Or is it away from the pull of gravity?) The third tree was bent over when another fell on it in a storm. Three of its side branches are now growing upright.

At the kindergarten level, we are told that children cannot develop a concept of plant response to sunlight. That is generally done in third grade (or is it fourth?) by putting a box over a geranium plant in the classroom window. Nevertheless, when the five-year-olds are asked what they have learned from seeing these trees, several in the class will invariably say, "All of the trees are trying to get up to the sun."

The other concepts necessary to an understanding of forestry can be developed just as easily as the child progresses through elementary school science.

Back to the quotation at the opening of the article from the sixth grader at Camp Westwind in Oregon. Last May, a different kind of "conceptual field trip" was tried with these students from Seth Lewelling School. As the field trip began, the children were asked to look for two things:

(1) evidence of change (concept: living things and the environment are in constant change); and (2) evidence that one living thing is dependent on another living thing—that living things are dependent on one another, or interdependent. (Concept: living things are interdependent with their environment and each other.)

The directions for the ten-minute field trip were simple: "In the next ten minutes, find as many examples as you can of change and dependence."

The children regrouped after ten minutes. They were loaded down with dead leaves, flowers, and seeds. The students saw all kinds of changes, and discussed how these were caused. They decided that changes in living things were:

1. natural (species)—buds → flowers → seeds → dead remains;
2. natural (caused by other living things)—chewed, sucked, mined leaves;
3. physical—storm, erosion, flood, time;
4. chemical—pH, mineral deficiency, salt spray;
5. man-caused (In another hour the children might have decided that man-made changes are also natural. Is not man a natural animal?)

The children further decided that changes are going on all the time. Living things change, environments change, sixth graders change, constantly.

Concepts of dependence and interdependence are just as quickly developed through this type of experience. In the very short time spent on the field trip, the children are beginning to develop the third major concept of environment—*living things are the product of their heredity and their environment.* This concept also applies to populations of organisms. What would happen if an animal ate *all* the leaves of a tree? If man killed all grouse? Why are two Sitka spruce trees different? Two daisies? Two sixth-graders?

This type of field trip means a new role for the teacher—but it is an enjoyable one. All he has to do is direct his students to new experiences and help them explore unknown environments. Let them develop their own concepts of environment. Then every new experience they have in the environment in the future will reinforce their concept or cause it to be modified.

Sixth graders from Seth Lewelling School at Camp Westwind "exploring the unknown environment" inside a tree with the aid of an increment borer.

Outdoor Education School

THOMAS PASKALIDES, Elementary Physical Education Supervisor
EUNICE BURDETTE, Supervisor of Elementary Schools
THOMAS HOWIE, Helping Teacher
WILLIAM LASLO, Helping Teacher in Science
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CHILDREN learn best through firsthand experiences. In keeping with this commonly held principle, the Outdoor Education Program sponsored by the Prince George's County Board of Education has demonstrated success in bringing real experiences into the lives of many elementary school children.

Each school year approximately 600 elementary school students have an opportunity to spend a week at an outdoor education school. Presently, the school is held at Camp Letts, a local YMCA camp located near Annapolis, Maryland, on Sellman's Creek. Two one-week sessions are held here in September for sixth graders and two in May for fifth graders.

Recognizing the importance and potential learning development in outdoor education, the Board of Education has initiated plans for the establishment of a center for outdoor education in Prince George's County. The plans call for an ultimate tract of land, approximately 500 acres in area, to be set aside as a field laboratory for learning. Here, children will have opportunities for direct, firsthand experiences in exploration, discovery and research.

In preparation for participation in the Program, two-day training sessions for classroom teachers are held prior to the students' arrival at the School. During these sessions, teachers become familiar with the program, the facilities, and the school personnel. The personnel for the program consists of ten permanent staff members, ten resource teachers who teach a specific area, sixteen junior counsellors (high school students) who assist the staff and resource teachers as well as monitor groups of pupils, and eight classroom teachers (accompanying their own classes).

The curriculum of the one-week sessions is arranged so that students can relate regular classroom programs to the outdoor activities. The basic objectives of the program are:

1. To recognize the value of natural resources and to learn to use them wisely.
2. To increase emphasis on science education and to

Note: Individuals interested in further information about the Outdoor Education School are invited to correspond with the authors.

Nature trail development is one of the many daily-scheduled activities at Camp Letts.

give each student a chance to develop increased knowledge and interest in adaptation of animals and plants for life in water and on land, the changing surface of the earth, and interrelationships in the environment.

3. To make classroom learning more meaningful through the application of knowledge to practical situations.
4. To learn to live democratically with other children and with adults through experiences in outdoor living.
5. To develop skills and interests in outdoor education which will carry over into later life.
6. To gain knowledge about natural resources from direct associations with nature.

Each child is expected to attend and take part in the daily-scheduled activities.

1. Water Safety
2. Nature Crafts
3. Camp Crafts
4. Stalking and Observing
5. Weather Study
6. Mapping and Orienteering
7. Bait Casting
8. Nature Trail Development
9. Shoreline Ecology
10. Insect Study

The evening activities also have a built-in motivation. They are designed to broaden the child's interests and deepen his appreciation in these "after supper" activities. Evening activities include:

1. Square Dancing and Social Mixers
2. Nature Oriented Games
3. Council Fire
4. Astronomy
5. Bird Banding
6. Poetry Appreciation

Children simulate rushing water conditions in order to examine the effects on the land.

From the beginning in the spring of 1960, when one class of thirty fifth-grade children pioneered this new approach to learning, the growth and expansion has been encouraging. Once again this May, 280 fifth-grade students will be transported by bus to the outdoor education school site for one week of simple exploration and investigation, discovery and research.

A true evaluation of the results is difficult. Certainly a specific focus toward the development of principles in outdoor education and conservation along with a greater emphasis on scientific understandings has taken place. The experience also indicates that the outdoor education program has certain unique contributions to make regarding the emphasis on learning. These basic learnings, along with intelligent and enthusiastic guidance, motivate children to respond to and contribute more fully to the use and improvement of their immediate environment.

Looking ahead to the future, as Prince George's County becomes more densely populated, there will be much greater need for study in the out-of-doors with compensating experiences. The Prince George's County outdoor education program will continue to provide firsthand experiences and a foundation for a more broadly educated citizenry.

Outdoor education participants learn to estimate the age of a tree from a cork sample.

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America's Open-Air "Classrooms"

THE finest teaching resources for science and environmental education available in the United States are to be found in the two million acres of National Park land and the more than 28 million acres of land including National Monuments, National Historical Sites, National Seashores, and other National Landmarks.

In their origin, National Parks and Monuments are chosen for preservation and conservation on the basis of their natural features and unique scientific interest. At Lassen Volcanic National Park in California, one can see vivid evidence of the fiery eruptions which took place as recently as 1917. On the flanks of Washington's mighty Mount Rainier, one can see great valley glaciers actively carving the sides of this "sleeping" volcano. At Petrified Forest National Park in Arizona or Dinosaur National Monument in Utah, one can view some fascinating chapters of earth's earlier inhabitants and history. In short, these areas with their multitude of geologic and biologic attractions are outdoor laboratories where much can be learned about the earth.

Because of the great increase of tourism and outdoor education within recent years, large numbers of youngsters are visiting the National Parks and Monuments. Consequently, good use can be made of these areas to relate students to various aspects of science, especially those dealing with geologic topics. Even if they do not visit the parks, many students are introduced to the wonders of these areas in their geography and social studies classes.

THIS ARTICLE has been adapted from *A Guide to the National Parks: Their Landscape and Geology* by William H. Matthews, III, The Natural History Press, Garden City, New York, 1965.

← JIM LEE, BUREAU OF LAND MANAGEMENT

Science and Scenery

The National Parks offer an unbeatable blend of science and scenery—picturesque and remote wilderness areas with explorable terrain. Young investigators can grasp understandings in biology and geology from the combinations of life forms and their physical surroundings apparent in an area. Glaciers and snowshoe rabbits, volcanic craters and silversword plants, and snow-capped mountains and alpine fir, are among the bio-physical elements that combine to compose the natural history of an area. These organic and inorganic constituents of the

landscape are closely related and interdependent.

Rocks: The Raw Materials of Landscapes

Most of the features of the natural landscape are composed of or have been carved into solid rock. The National Parks derive much of their beauty from the character of their exposed rock formations and the effect of geologic agents upon them.

Because rocks are the raw materials of geology and the "stuff" from which landforms are shaped, it is helpful for students to know something of rocks' general characteristics and their role in the development of the landscape. What is a rock? It is a naturally formed physical mixture of minerals that makes up an appreciable amount of the earth's crust. The minerals are naturally occurring substances which have fairly definite chemical compositions and which occur in definite shapes called crystals.

Geologists believe that all the rocks of the earth's crust originated in three general ways and have been classified accordingly — *igneous*, *sedimentary*, and *metamorphic*. Igneous rocks were once hot and molten (magma) which later cooled and solidified to form such common rocks as lava and granite. Even though 95 percent of the outermost ten miles of the earth's crust is composed of rocks of igneous origin, they are not as common on the earth's surface. Igneous rocks appear exposed on the surface in areas that have undergone much erosion by wind, water, and weather, i.e., the granite domes of Yosemite, the saw-toothed peaks of the Tetons, and the coastline of Acadia. Where magma has spilled out upon the earth's surface through a great fissure, volcanic cones have formed mountains, i.e., in Lassen Volcanic, Mount Rainier, Crater Lake, Hawaii, and Haleakala National Parks. In some cases, the lava reached the surface in fissure flows over a broad area and has left formations such as those in Isle Royale, Shenandoah, and Yellowstone National Parks.

Sedimentary rocks are formed by the compaction and cementing together of rock fragments called sediments. Sediments may be deposited by wind, water, ice, and in the sea to form sandstone, limestone, clay, and shale. Although only 5 percent of the earth's outer crust is made up of sedimentary rock, 75 percent of the rocks exposed on the surface are of this type. The Grand Canyon provides geologists with a "slice" of the earth's crust where the succession of sedimentary rock strata presents billions of years of geologic record. Ripple marks, cross-bedding, mud cracks, and fossils which are characteristic in the layering of sedimentary rock are found widely throughout the Parks.

Metamorphic rocks were originally some other rock (igneous, sedimentary — even another metamorphic rock) that has been greatly altered by heat and pressure to form a completely different type of rock. Thus, granite may be metamorphosed into gneiss (nice), shale into slate, and limestone into marble. As would be expected, metamorphic rocks are more common in areas that have been subjected to severe crustal intrusions. Because they have had more time to undergo such change, metamorphic rocks are usually of very great age. Exposures crop out in the inner gorge of the Grand Canyon and in many other Parks.

Ecology in the Parks

Just as an acquaintance with geology will facilitate an understanding of the meaning behind Park landscapes, the science of biology provides a behind-the-scenes view of life in the National Parks. Most of the Parks have their own distinctive types of living community—*flora* (plant life) and *fauna* (animal life) native to that area. Each organism is closely interrelated with and frequently dependent upon the other plants and animals that are around it; and moreover, they are all dependent upon their physical surroundings. In fact, in most Parks it was the physical environment that originally attracted life to the area. In addition, by its activities, each organism affects its environment and is itself affected by the ever-changing landscape.

The study of the interrelations of plants and animals with one another and with the physical features of their surroundings is called *ecology*. Derived from the Greek word *oikos* which literally means "home," this increasingly important branch of biology deals with the "home life" of organisms—their relation to one another and to their living and nonliving environment. Because this environmental science addresses itself to all phases of our surroundings, it has sometimes been called "the science of everything." And, dealing as it does with the reasons behind plant and animal communities, ecology has also been called "the science of togetherness."

The National Parks are ideal places for students and teachers to observe natural plant and animal assemblages because the National Park Service is dedicated to the preservation of normal ecological conditions within each area submitted to its charge. For visitors, the Parks provide Ranger-Naturalists who conduct nature walks and other interpretative services designed to call attention to each area's special ecological significance and emphasize man's responsibility to help maintain proper natural conditions. Also, interpretative markers on Park nature trails explain the relation of organisms to their biological and physical environment.

Wildlife in the Parks

In order to insure the proper balance of nature, the wildlife management policy of the National Park Service states "The whole natural community of an area shall be subject to a minimum of human interference or manipulation, and there shall be a free play of natural forces and processes." Thus, visitors have the opportunity to see the animals in their natural environment relatively undisturbed by man.

There are a number of reasons why the fauna and flora of the Parks should be preserved. First, the natural plant and animal life add

greatly to the interest and beauty of each area; second, the plants and animals native to the area are able to live more safely in their natural habitat than elsewhere; and third, these natural game preserves are ideal field laboratories for biological research and observation. Consequently, zoologists and other biological scientists and their students visit the Parks each year in order to study these undisturbed animal communities under the most natural conditions possible.

To further assure a natural environment for these wild creatures, the animal life in the Parks is protected by Federal law, and Park Rangers are on hand to make certain that the law is enforced. Indeed, the preservation of certain species of wildlife has been one of the prime reasons for the establishment of certain Parks. For example, Mount McKinley National Park was established to preserve Dall sheep, Olympic Park was established to protect the Olympic or Roosevelt elk, and Everglades National Park provides a sanctuary for a host of subtropical birds.

Native Vegetation in the Parks

The plant life of the National Parks is also protected by National Park Service policy and picking wildflowers, removing plants and shrubs, and the indiscriminate cutting of trees and underbrush is not permitted. In those areas where it is necessary to thin vegetation for the construction of roads, trails, or campgrounds, the thinning is done carefully and sparingly. Moreover, Park personnel take special precautions to maintain the proper balance in nature in order to allow the thinned area to look as natural as possible. In areas of historical significance the vegetation is usually maintained in, or restored to, a condition similar to that which prevailed at the time of the event being commemorated.

In addition to the prevention of damage by human activities and forest fires, Park Service personnel also take precautions to prevent losses from plant diseases and epidemic forest insects. Steps are also taken to eliminate non-native plants and to protect vegetation from damage by grazing and browsing animals.

Certain of the National Parks are famous for their trees. The giant sequoias of California's Yosemite, Kings Canyon, and Sequoia National Parks, are the largest trees in the world. Some are estimated to be between three-and-four-thousand years old. Other large trees, among them the western hemlock, Sitka spruce, and western red cedar, thrive in the wet rain forests of Olympic National Park on the Olympic Peninsula in Washington.

One of the outstanding features of the National Park forests is their natural and primitive character. In fact, these forests might properly be considered "forest museums" in which normal processes of nature are given free rein.

But trees and forests are not the only forms of plant life for which the Parks are famous. Many are well known for a specific type of vegetation. Thus, Texas' Big Bend National Park is famous for its desert plants and Everglades National Park, Florida, for its lush tropical and subtropical vegetation. Still other Parks are noted for their colorful displays of flower "shows."

Use the Parks to Teach

Thus, the physical features and life forms of the National Parks are the basic ingredients of the Park's spectacular scenery. The biology and geology of these scenic areas are blended together in a harmony of existence. By exploring and observing this balance, children can learn to appreciate more fully the great age of the earth, its fascinating history, the complexity of its structure and composition, and come to know the myriad plants and animals that inhabit it.

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A Biotic Community with People

YOUR TOWN

PEOPLE are *a part* of the natural scene, not *apart* from it. Our concern about the population explosion and the pollution of air, water, and soil bears witness to our dawning awareness of the fact. The ecological emphasis of the new elementary life science materials is further evidence of our concern to help people understand their relationship to the earth which sustains them.

The concept of the *biotic community* is used to help children understand food, space, and other relationships among living organisms. If children's studies of plants and animals have emphasized these interdependencies, it will not be difficult for them to comprehend the community idea.

Many text and popular books for both children and adults describe the biotic community. They picture the food producers (the green plants), the plant eaters (herbivores), the animal eaters (carnivores), and the scavengers and decomposers. The food cycle is accompanied by the cycling of oxygen and carbon dioxide, and thus the paths of energy flow are traced through the community. In a sense, the community idea is abstract. It is man's way of generalizing the interactions which do occur somewhere. All of the "somewheres" are the many habitats where plants grow and creatures dwell.

There is a great diversity of habitats, and each one has definite characteristics which are determined by one or more dominant influences. We are now acknowledging man as the dominant influence in many areas. Man's activities have altered many environments to an extent that they bear no resemblance to the area as it existed before man arrived. In some places, such as pavements, the new environment cannot support life

of any kind. In others, native populations have been completely destroyed and replaced by other populations. For example, forests have been replaced by farms, marshes have been filled and are now the sites of suburban dwellings. (See suggested Activity 1.)

The most obvious man-dominated community is the city. From the sociologist's point of view, the city is a human community with all of the specialized tasks (dispensing of goods and services and governing) performed by people. This is but one level of organization—the social organization of one kind of animal, one population.

From the biologist's point of view, the biotic community, which includes the population of man, is a larger, more inclusive group. It includes plants used in landscaping, agricultural crops, dogs, cats, and other pets, and domesticated animals raised for food. It also includes rats, sparrows, roaches, and weeds.

When we view an urban area as a man-dominated biotic community, we see many associated organisms in a new light. Most city plants are introduced into the area by man, often deliberately, sometimes accidentally. The most obvious are trees which may have been selected because they offer the best combination of hardiness and shade. Along many streets, the trees must be capable of surviving with little water because so much of the area around them is paved and rainfall runs off into storm sewers instead of soaking into the soil (Activity 2).

Trees provide food and shelter for many kinds of animals. Insects eat some of the leaves or burrow into the bark. Birds feed on the insects, and both birds and squirrels eat the fruits (Activity 3).

Parks, dwellings, and commercial buildings have varying amounts of landscaping which include a wide variety of vegetation. The vegetation may harbor a wide variety of insects. The soil beneath the shrubs, lawns, and along walls is often well-populated (Activity 4).

People bring animals into the city. Cats, dogs, caged birds, aquarium animals, and a few kinds of small mammals are popular pets. Zoos and aquaria are "living museums" where a large variety of animals resides. Pets and caged animals are fed, sometimes with their own native foods, but more often with human agricultural products (Activity 5).

One interesting aspect of the man-dominated community is the large variety of populations of the uninvited. Some writers refer to these populations as "camp followers," which find the "better life" because of human activity.

If these organisms compete with man for food and shelter, or if they threaten man's health, they are called harmful and are considered pests. Rats, mice, roaches, and flies are among these unwelcome followers. They populate areas where food is stored, prepared, or served, and where garbage is dumped. Man's buildings and trash heaps provide myriad small, dark places where animals can dwell (Activity 6).

Other camp followers are abundant yet not so deeply scorned. House sparrows, pigeons, starlings and squirrels thrive because, like the pests, they are able to eat a large variety of foods and nest in a variety of places. These animals are also tolerant of man's presence (Activity 7).

Weeds are the plant kingdom's representatives among the camp followers. A weed is any plant which grows where man does not want it to grow. The word "weed," therefore, is a general term which describes man's attitude of rejection or indifference toward a certain kind of plant. But weeds are interesting organisms. Some kinds survive mowings and thrive in lawns. Some kinds have long tap roots and survive in the dry, hard soils on and along footpaths or in cracks in pavements. Although these hardy plants may be considered pests in some places, they may conserve water and soil and provide the base of a food chain in what otherwise might be a lifeless place (Activity 8).

Human communities, from the small rural village to the densely populated city, are biotic communities populated by thousands of plant and animal populations. Some are there because of man; some survive because they can tolerate man and his activities.

Laboratory Activities

The outdoor laboratory experiences suggested here can help children see their town or city as a man-dominated biotic community. Most of the activities emphasize seeing the plants and animals which are present and investigating conditions which make it possible for them to survive.

The community idea will not be demonstrated unless relationships and interdependencies are stressed. Food relationships are among the easiest to observe. For example, much of the food for all of the animals is brought into the community by man. After children have done some investigating, observing, and measuring, the teacher can help them diagram some food chains. Many of the dwelling places used by small animals are a result of man's activities. For example, the design of older buildings offers nesting and roosting places for house sparrows, pigeons, and starlings. Are there changes in the sizes of these bird populations as new buildings replace the old?

Activity 1.

If an area near the school is changing rapidly (tearing down of old buildings, new construction, new parks, new stores and parking lots), note the changes during a few weeks or months. Do this with photographs if possible. Often such man-made changes will cause observable changes in the plant and animal life as well as in temperatures and humidity. Do the changes alter the kinds and/or numbers of dwelling places and sources of food? What evidences of the presence of plants

and animals are there before, during, and after the changes?

(Note: If construction is underway, do not overlook opportunities to learn how man extends his capabilities through the use of tools and power.)

Activity 2.

Trees

a. Characteristics: Before identifying the trees, take time to examine their characteristics. Forms and kinds of trees vary with the environment (soil, temperature, water, and quality of the air).

   How large are the trees (height, size of crown, girth of trunk)?

   Are they deciduous or evergreen?

   How much bare ground surrounds the base of the tree?

   Estimate the amount of water available to soak into the soil near the tree per year (average annual rainfall times area).

   What other sources of water does the tree have?

   Find two or more trees of the same kind which show different conditions of health. Try to account for the differences you see. For example, trees in the park may appear healthier than trees of the same species along the street.

b. Identification

   Find out what kinds of trees are in the area.

   Try to learn from your local parks department, or other agencies, when they were planted and why these kinds were chosen. Perhaps they occurred naturally and were protected.

   Use reference books to find out more about each kind of tree. If it is not native to your region, what are its origins? What characteristics enable it to survive where it does?

   Is this tree a good or poor "street tree"? Is it able to remain healthy in the city environment?

Activity 3.

Many of the trees and shrubs bear fruit (fleshy or dry) which are eaten by birds and other animals. Observe the flowers, then the fruits of the plants in your area. Watch the birds and try to find out what they are eating. They may be eating plant products or they may be eating insects which live on the plants.

Collect leaves which show some damage by insects. The insects with chewing mouthparts bite chunks from leaves. Those with piercing, sucking mouthparts probe the veins of the leaves. These leaves may curl and turn brown. Try to find out if a tree or shrub is the first link in one or more food chains. Perhaps you can describe a chain of several links which starts with the tree.

Activity 4.

With a trowel, get samples of soil from different locations around the building. Notice whether it is damp or dry. Measure and record the temperature of each place where you collect. Spread the sample on an old newspaper, pick out the animals which you find, and put them into a jar. You may find earthworms, sow bugs, crickets, and other small animals. How many kinds did you find in each sample? Try to relate numbers of kinds and numbers of each kind to the conditions (moisture and temperature) of the place you sampled.

Keep your record and repeat the activity during another season. Compare the results. It is not uncommon to find soil animals active during the winter months. Populations in many little habitats vary from season to season, but the habitats are rarely devoid of life.

Activity 5.

Plan a trip to the zoo. Most zoos have someone on the staff to help teachers plan trips. Ask that food be the focus of study for your trip. Find out both the native foods of the animals and the foods given them in the zoo. What are the sources of the zoo foods?

Notice also how the animals use their mouths and appendages to obtain and consume the food.

Census the pets owned by children in your class.

Ask children to list the foods eaten by the pets and to find out the sources of the foods.

Use references to find out: What are the closest wild relatives of the pets? What are the natural foods of the wild species? How are the habitats similar to those of the pets?

Activity 6.

Undoubtedly, the children will be able to list animals which are considered to be pests. Census those which are known to be present in the area or list places which could harbor animal pests. Conjecture what animals could live there. Support your guesses.

You may be able to demonstrate short food chains. For example, a place which harbors mice has in it food which mice will eat. It may also harbor cats which eat the mice.

Activity 7.

The "camp followers" which man tolerates are interesting animals to study. Generally speaking, an animal lives where it does because it is able to survive there. That means that it finds food and dwelling space and that its reproductive rate is at least as great as its death rate. House sparrows, pigeons, starlings, and squirrels are probably the most common city animals tolerated by man in North America.

Where do these animals live? Notice the roosting places on buildings, the ivy-covered walls, the hollow trees. Find out what these animals eat by watching them.

Activity 8.

Most of the plants which we call weeds survive because they are able to survive a wide range of soil and climate conditions. Find out the variety of habitats in which a certain kind of weed can live by looking around your school area. Investigate shrub borders and waste places and measure a few specimens in each place. Notice how the specimens differ from place to place. Notice sizes and textures of leaves, rosettes, flower stems, and roots.

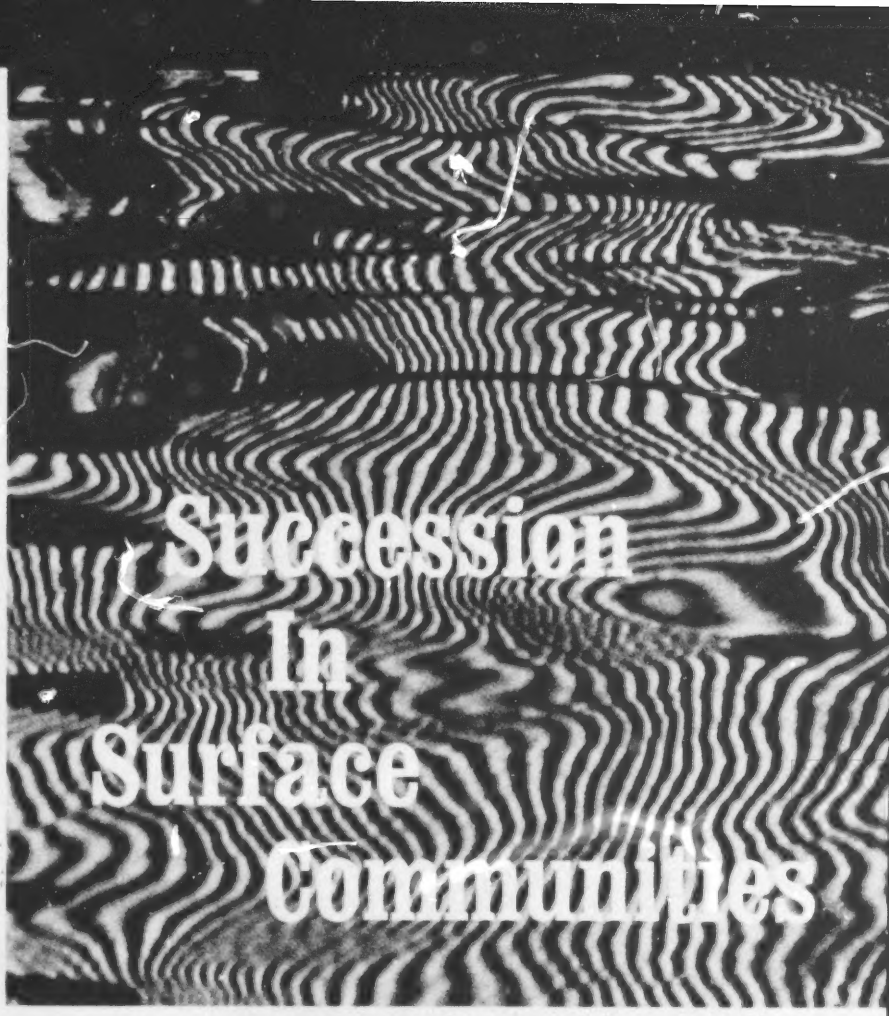
Dig up a dandelion from a hard, dry soil. Plant it in a pot of loose, fertile soil and keep it watered. What happens?

Summarizing the Investigations

Compare the interrelationships in your man-dominated community to those of a community where man's influence is not so great (a desert, an isolated sea shore, an "uninhabited" island, a large forest).

What plants and animals are in the community because of man's activities? Which are there only because they can tolerate man?

What and where are the producers, the consumers, the decomposers?



Succession In Surface Communities

PETER P. FAIELLA

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John J. Daly School
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THERE are many techniques used by scientists which, when simplified, can be used for the instruction of children. While involved in a teacher training program at New York Ocean Science Laboratory, Montauk, New York, Anthony D'Agostino, a researcher there, used an interesting approach to the study of seasonal succession of organisms of surface encrusting (fouling) communities. The techniques he employed could be modified as suggested here for collecting and studying live organisms in the field or the classroom.

Materials

1. Obtain a wire or plastic basket, preferably one that is sturdy and noncorrosive (those used for delivering milk work well). See Figure 1. If no basket is available, an open cement block could be used with the slides suspended from wires run through the holes in the block.
2. Attach spring-type clothespins to the crossbars of the basket, and attach a slide to each clothespin. See Figure 2.
3. Use a hemp or nylon rope to make a bridle on the basket and attach a line to it. Place a heavy stone in the basket for weight.

FIGURE 1.

Procedure

Suspend the basket in a calm channel or bay, from a dock or other stationary object. Colloidal and suspended matter in the water will attach itself to the glass slide, thus effectively concentrating organic molecules. Eventually this organic surface film will serve as a source of nutrients for the microscopic organisms which settle on the slides. Bacteria will be the first of a series of populations of organisms that will become abundant in succession in the establishment of a surface fouling community; they will appear on the slides within a week. The following chart illustrates the sequence of organisms that will become abundant on the slides after increasingly longer immersion periods.

Bacteria
24 hours after immersion. Numerous bacterial colonies usually made up of rod-shaped cells. (Magnification 400X.)

Diatoms
48-72 hours. Boat-shaped light brown cells. (Magnification 100X or 400X.)

Ciliates
4-6 days, Paramecium and euplotid-like cells. (Magnification 50X.)

Rotifers
Nematodes
6-7 days may occur. (Low magnification.)

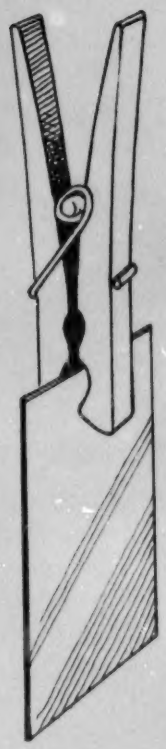

FIGURE 2.

Mud-Blister Worms
Coelenterates
Second or third week. Colonial coelenterates such as obelia may appear. (Low magnification.)

Crustaceans
Molluscs (Crepidula)
Organisms will vary with the season. Ostocods and barnacles may become part of the community. (Low magnification.)

Germinating
Seaweeds
May or may not occur, depending upon the season. In the spring enteromorpha and codiaceae may be observed under low magnification.

Hay Infusion

If saltwater channels or bays are not accessible, hay infusions may also produce interesting successions. Boil 250 ml of tap water; place it in a clean beaker and cool. Add one teaspoon of mud and some dry hay; allow this mixture to stand for at least one week.

The organisms which develop will depend upon the cysts or organisms found in the hay or mud. Organisms are usually concentrated on the surface film of the water or at the mud-water interface at the bottom. Therefore, samples for wet mounts should be taken from these spots, not from clear water. Slides may also be suspended in the beaker, as in the other procedure.

The organisms may become abundant in the following sequence:

Bacteria during the first week
Amoeba during the first and second weeks
Ciliates during the second and third weeks
Rotifers during the third week
Nematodes during the third week if there are eggs in the mud or hay.

SYLVIA K. SHUGRUE

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District of Columbia
Public Schools
Washington, D. C.

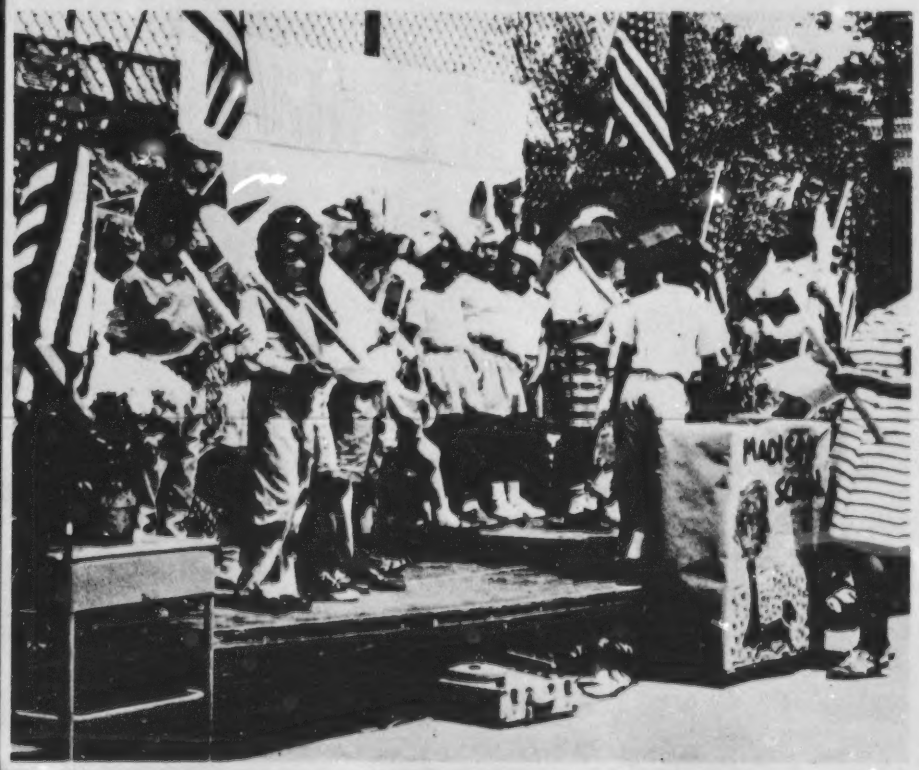
TEACHERS and students throughout the country are becoming involved in the development and use of Environmental Study Areas. This report describes how one inner-city school found that its area not only provided an environmental learning site for children, but it also served as inspiration for change in an entire neighborhood.

THE Urban Environmental Study Area at the Madison School in Northeast Washington was first conceived as a result of a search for a practical demonstration of theoretical ideas developed in a teacher training class in environmental education at the D.C. Teachers College. The site chosen was established through a cooperative effort of the National Park Service and the D.C. Public Schools to afford students of Madison School and ten nearby public, parochial, and private schools of this inner-city area an introduction to environmental diversity.

To show this diversity, the National Park Service designed a landscape plan which provided for five basic life-zones or ecosystems for the severely eroded area of the school property chosen for the ESA site—grassland, desert, semi-arid (transitional area), cropland, and forest. All the numerous stages of preparation were handled cooperatively among the National Park Service personnel, the children, and the teachers. Activities for each grade were then correlated with the existing science curriculum guide for the city schools.

Soil samples were examined, as well as the compactness of the area. Together the groups made observations of the erosion and drainage problems and surveyed the facilities available to maintain plants and soil. The sub-soil present was not fertile enough to support plant life, so a retaining wall was decided upon and fourteen cubic yards of topsoil added to the area. Plants arrived and the children assisted in the planting and care which followed.

Through these steps, the students were exposed to and helped to solve the problems of reclaiming a barren site. Each pupil became a responsible and active citizen concerned for the maintenance of the quality of his school site environment.



On May 23rd, the entire Madison Elementary School population as well as members of the surrounding community celebrated the dedication of their completed Urban Environmental Study Area (left). After the dedication (above), the students held a block parade to alert the neighborhood to the summer program, "Our Block of Earth."

(See page 42.)

SYLVIA K. SHUGRUE

Science Teacher
District of Columbia
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THOMAS L. AYERS

Soil Conservation Society
of America
Washington, D. C.

A Concern for Conservation

BECAUSE the teaching of conservation demands a synthesis of information from many disciplines and a mastery of many and diverse skills, it is one of the most difficult areas of the elementary science curriculum to implement. In addition, the discipline imposed by nature demands much learning and labor for rewards which are long delayed and sometimes uncertain. It is, therefore, imperative to the success of a conservation project that motivation be dynamic and sustained.

Early in her Beautification Program, Mrs. Lyndon B. Johnson enunciated what may be the keynote to the development of an instructional program in conservation, one which would insure change in the habits and attitudes of children. Mrs. Jonhson's beautification campaign stemmed from her own spontaneous response to natural beauty and a corresponding concern for conservation. This spontaneous response is universal in children, a dynamic motivating force readily sustained through the science program.

The effort to improve school grounds in the Nation's Capital directed attention to a fact so obvious as to be overlooked: The school ground may be the only soil available to urban children for study, management, and improvement. It affords a readily available outdoor laboratory to complement the classroom instructional program in the study of plant life.

In order to facilitate the use of the school grounds as a laboratory, it is necessary to develop a cycle of activities which are appropriate to the area, the season, and the resources readily available to the school. These activities should have continuity throughout the academic year, be adaptable to the maturity levels of the children, and offer opportunities for community involvement. The following calendar of conservation activities was developed and used successfully in many schools in Washington, D.C. Although it was designed for a specific geographic location, it provides a cycle of fundamental activities which could be readily adapted to other regions of the country. Help in adopting and carrying out the activities can be obtained by interested teachers from local representatives of state and federal agricultural and conservation agencies. Personnel of the county office building can direct teachers to agents able to give assistance and suggest published material which can be secured from local, state, and national agricultural and conservation agencies.

Conservation activities may be performed year round, making use of the classroom as well as the school grounds.

A Calendar of Conservat

PROJECTS	FALL			WINTER		
	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY
LAWNS	← Prepare, fertilize soil and seed grass. →			The maintenance of the lawn is the responsibility of school personnel (custodian). To encourage practices of conservation, children can participate in seeding, weeding, and anti-litter campaigns, and identifying native plants. →		
SOIL	← Study the components of soil by examination of samples collected. —					
	← Study the processes of soil building through trips into the field. —					
FLOWER GROWING	← Force bulbs (tulips, white narcissus, hyacinth). Note: Special bulbs for forcing must be purchased. →			← Store bulbs potted for forcing for approximately two months in a cool dark place indoors. Cover with plastic to retain water. Add water when necessary. Bulbs buried outside do not require watering. →		
	Prepare bulb beds (plant tulip, hyacinth, daffodil bulbs).					
	Harvest seeds from previously grown annuals (zinnias, marigolds, cockscomb).			←	At two-week intervals, bring stored bulbs into light of classroom, water, and observe flowers develop. →	
	Begin composting with leaves, straw, garden and kitchen vegetable refuse. If buried outside, watering not needed.					
VEGETABLE GROWING	← Grow lettuce in cold frames. →		←	Modify soil for growing seedlings and/or vegetables. →		
WINDOW BOXES					← Construct window boxes. →	
DISH GARDENS	← Prepare any time of year. Plants include: philodendron, cactus, succulents, ivy. —					
PROPAGATING ORNAMENTALS Windowsill Greenhouses Hardwood Cuttings Layering					← Propagate conifers such as yew and juniper and broad-leaf evergreens such as pyracanthus, lugustrum, and Chinese holly. →	
	← Propagate hardwood cuttings—mock orange, lilac, crepe myrtle, forsythia. Bury cuttings below freezing line. →					
TERRARIA			←	Study the needs of plants. Classify plants according to flowering or nonflowering. Observe the water cycle, the water table, the growth in terraria plants. Ornament the school room or home. →		
TREES	← Observe leaves, fruit, bark, root. Press leaves and observe their margins, veins, and midrib. Identify specimens and store for reference. →					
			← Harvest evergreens. Classify as to broad-leaf and needle-leaf varieties. Use cuttings for ornamentation. →			
				← Observe the structure of a tree from the classroom window. Record changes. Observe trunk, branching, and shape. →		

on Activities

	SPRING			SUMMER		
	MARCH	APRIL	MAY	JUNE	JULY	AUGUST
	← Fertilizing, watering, mowing, weed control (custodian). →					Seed eroded or damaged areas.
	← Press and identify native plants. Store samples for reference. →					
	← Plant flowers and vegetable seeds in window boxes or cold frames to be transplanted (February-March).			← Weed, cultivate, and care for summer flowers. →		
	Plant perenniels outdoors: tiger lilies, daisies, lily-of-the-valley, peonies, pansies. Grow house plants from seed.					
	← Plant summer annual flowers: marigolds, petunias, cockscomb, zinnias, nasturtium, asters, morning glories indoors for transplanting after frost.		← Seed annuals outdoors.			
	← Plan areas and prepare the soil for vegetable gardens. Plant vegetables: corn, lettuce, radishes, onion sets, cabbage, mustard greens. Transplant available vegetables and flower seedlings from cold frames. →			← Weed, cultivate, and harvest vegetables. →		
	← Prepare the soil and transplant flower seedlings, rooted cuttings to pots or window boxes. →					
	← Transplant plants previously propagated into beds. →					
			← Propagate garden flowers such as geraniums, lantana, and flowering shrubs such as forsythia, mock orange, and viburnum. →			
				← Propagate broad-leaf evergreens such as azaleas and camellias. →		
	← Observe the flowering parts of trees. →			← Collect and press leaves of local trees. →		
		Arbor Day				

From left to right: *Preparing dish gardens; Identifying leaf specimens; Preparing soil for window boxes; Forcing potted bulbs.* From top to bottom: *Caring for a newly planted tree; Storing bulbs; Preparing windowsill greenhouses; Harvesting vegetables.*

As described in "An Urban ESA" (page 38) the school and the community participated in an environmental program. Under the guidance of Simpson Jefferson, Sixth Grade Teacher, every student made a contribution to the Madison School site development. Numerous other school site development efforts have been guided by Sylvia Shugrue and are described in *Science and Children*. However, they could not all be included in this collection, due to space limitations. Articles of interest are:

"Science Can Be Beautiful," November 1966; "No Space for Soil," January/February 1972; and "Beautification of Billy Goat Hill," September 1969.

Before the topsoil arrived, the school grounds consisted of subsoil and clay which hardly supported the growth of weeds.

Every child in the school took part in the development of the site. The activities were arranged so that the children participated in accordance with the school science curriculum and at the children's various levels of maturity. For example, the older students took on the responsibility of planting and watering as needed in the life zones.

JANICE H. DAVIS

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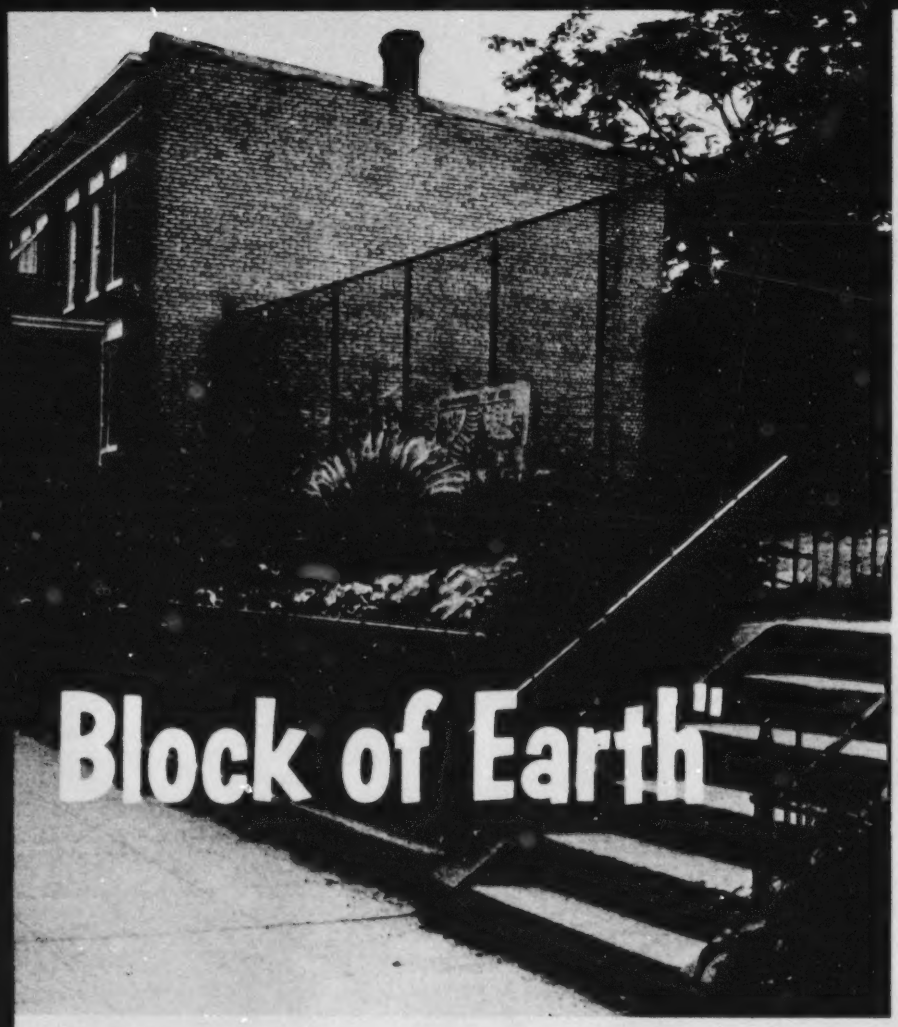
Washington, D. C.

THE success and pride in the urban ESA inspired the school and students to design a plan which would carry the enthusiasm over the summer until school reopened in the fall. A summer "Our Block of Earth" program emerged. Its intent was to preserve the existing urban Environmental Study Area (ESA) and to promote an awareness of and a concern for our environment among the community residents. These goals were accomplished through a grant from the Society for a More Beautiful Capital which made funds available to hire a community coordinator, four neighborhood beautification aides, a youth



Block of Earth"

garden consultant, and the purchase of necessary tools and garden supplies. The community coordinator also had the supporting services of a science consultant, personnel of the National Park Services, the use of National Park Service facilities, and assistance from various other government agencies.

By June 30th, when the summer program was initiated, the urban Environmental Study Area needed watering, weeding, and mulching. The staff and the neighborhood children set about these tasks and soon the area was flourishing with healthy plants and new seed plants which were purchased during the summer to insure the continuation of the urban Environmental Study Area.

"Our Block of Earth" also involved education at another level. The children and adults went on field trips together to various environmental centers in the metropolitan area to introduce the group community to other environments. These excursions provided excellent presite and follow-up activities at the urban ESA for the Youth Serving Youth Tutoring Center, which operates a summer program under the D.C. Public Schools Department of Pupil Personnel and is composed of junior high school and elementary school children.

The results of the summer project were amazing. Not only had we developed an awareness and a concern for the environment, but we had beautified the community and involved the neighborhood families at all levels. The project had instilled a renewed sense of pride, a community spirit, and a feeling of hope which had long been absent on that one block. The cooperative spirit has since spread to neighboring blocks whose residents are now improving the appearance of their "Blocks of Earth."

As the site began to grow, the conditions of the nearby grounds were surveyed by students, school personnel, Cecil Grant and Thomas Young, and Richard Brillantine of the Office of Beautification (above). The result—barren soil between the sidewalks and curb was cultivated, seeded, and watered. In August, the Society for a More Beautiful Capital and the summer program staff culminated the activities with a reception and a walking tour of the community. Richard Dabney received an award for his outstanding efforts from Society representative Polly Shackleton (below).

The Environmental Education Act

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Bureau of Elementary and
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U.S. Office of Education
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MAN'S capacity to change the face of the earth has taken on alarming proportions in the last thirty years. His needs, increasing because of technological advances, have resulted in a situation in which nature can no longer replenish itself. The result is pollution of the air, water, and earth.

Environmentalists everywhere deplore the ravaging of the landscape by strip mines, observe the careless spillage of oil in our coastal waters, and note the effects of insecticides on every form of life, realizing gradually how much man is a part of a giant web in which he controls the master strand.

The youth of America reacted to this environmental destruction by organizing community-wide programs to clean up the environment and demanding courses in environmental science. These activities culminated in Earth Day (April 22, 1970).

The Ninety-first Congress, in response to the public's demands, made an effort toward regulating environmental quality through the enactment of several pieces of legislation, of which the major one, the Environmental Education Act, will be described in detail later in this article.

Among the other efforts by Congress to control the environment was the National Environmental Policy Act, which established a Council on Environmental Quality in the Office of the President. Next, the Endangered Species Act provided measures for protection of our threatened wildlife. A Tax Reform Act included a section which provided tax incentives to industry in return for its cooperation in installing pollution control devices. Congress also requested a two-year study of all fundamental questions relating to population growth by the Commission on Population Growth and the American Future. Amendments to the Federal Water Pollution Control Act enforced through the Office of Environmental Quality, provided for fines to violators, such as oil companies, who pollute America's waters.

But the major landmark in environmental legislation, the Environmental Education Act, offers a different kind of hope, since it is not mainly concerned with cleaning up the mess we have made of the environment so far. Enacted on October 30, 1970, it had taken over six months to be developed and passed by Congress.

Edward Weidner, Chancellor of The University of Wisconsin, Green Bay, said in his testimony before the Committee on Education and Labor, "The crisis is rooted in attitudes that have allowed all of us in our business, industrial, domestic, and recreational activities to do things that have had a massive and cumulative degrading effect on our environment." John Olive, Director of the American Institute of Biological Sciences, supported Dr. Weidner's assertions. "We can be successful in developing an ecological conscience, a respect and reverence . . . ," he said.

Environmental education, in the view of the legislators who developed the Act, is "the educational process dealing with man's relationship with his natural and man-made surroundings, and includes the relation of population, pollution, resource allocation and depletion, conservation, transportation, technology, and urban and rural planning to the total human environment."

Of particular interest to educators will be the Office of Environmental Education which will be established in the Office of Education

to administer this Act. The program will move forward under the supervision of the U.S. Commissioner of Education through regulations published by the Secretary of the Department of Health, Education, and Welfare.

The Act will provide for making grants to and contracts with state departments of education, local school districts, organizations, and institutions to support research demonstration and conduct pilot projects designed to educate the public about the problems of the environment.

Money received through grants or contracts may be used to:

1. Develop curricula which may involve several disciplines and are directed to preserving and enhancing environmental quality and ecological balance;
2. Disseminate information relating to curricula and to environmental education;
3. Support environmental education programs at the elementary and secondary education level;
4. Permit preservice and inservice training programs including fellowship programs, institutes, workshops, symposia, and seminars on the teaching of environmental education;
5. Plan for outdoor ecological study centers;
6. Produce community education programs focusing on environmental quality;
7. Prepare and distribute materials to the mass media on topics relating to environmental quality.

Funds may also be used in demonstrating, testing, and evaluating environmental efforts. The guidelines and regulations for proposals have not yet been developed; appropriations to permit funding still need to be considered and passed by Congress separately.* Requests for assistance must be directed to the U.S. Commissioner of Education, who will make the final decision on proposals, but state education agencies must be notified of efforts within their states. States will have an opportunity to recommend the feasibility and plans of any given project in their state.

A 21-member Advisory Council on Environmental Education has also been provided for by the Act. Members, to be appointed by the Secretary of Health, Education, and Welfare, will include, among others, three ecologists and three students. The Council's responsibility will be assisting the Commissioner of Education in establishing guidelines and regulations for would-be projects.

The Act provides for technical assistance to state departments of education and local school districts, designed to enable the grantees to carry on education programs relating to environmental quality and ecological balance.

Citizens' groups and volunteer organizations interested in improvement of the environment will be eligible for small grants not exceeding $10,000. Efforts will focus on courses, workshops, symposia, and other types of conferences on environmental education.

The Environmental Education Act holds vast potential for public schools, states, communities, teachers, and universities to participate in environmental improvement. Its success or failure depends on you, the teacher.

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*The Environmental Education Act 1972

For fiscal year 1971, $1,725 million were granted under Environmental Education Act funding to 74 projects. These 1971 projects are summarized in *The New Environmental Education Program in the U. S. Office of Education* (PE-72-41), a brochure.

About $3 million has been allocated for 1972 environmental education projects which fit into one of three major categories – Small Grants up to $10,000, Statewide Evaluation and Dissemination, and Pilot Projects and Demonstration Models. *A Handbook on Preparing Proposals*, specifically directed to developing environmental education activities to be funded under the Environmental Education Act (Public Law 91-516), may be obtained from the Office of Education, Department of Health, Education, and Welfare. In general, preference will be given to projects appropriate for statewide or areawide programs and to activities demonstrating nonformal and innovative approaches. All projects will be selected through national competition.

For further information on the Environmental Education Act contact the Office of Environmental Education, U. S. Office of Education, Washington, D. C. 20202.

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